Oleg Tikhomirov

The Psychology of Thinking

Progress Publishers

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Chapter One

THE SUBJECT AND METHODS OF THE PSYCHOLOGY OF THINKING

§ 1. The General Philosophical Prerequisites of the Study of Thinking

The study of thinking is one of the traditional branches of general psychology, and therefore the interpretation of the subject examined by the psychology of thinking will depend on the understanding of the subject of psychology at large. We study psychology on the basis of the methodological principles of Marxist-Leninist philosophy, the science of the universal laws of the development of nature, society and thinking. The subject of psychology is defined by the following general philosophical tenets:

1. Psyche originates at a certain stage of the development of matter, and is secondary in respect to the outside world.
2. Psyche functions as a property of particularly organised matter (in its highest manifestations, as a property of the brain).
3. Being a reflection (cognition) of the outside world, it is in itself cognisable just as other phenomena.
4. Human psyche is socially and historically conditioned.
5. Psyche emerges on the basis of the subject's practical relationship with the outside world and performs an active part in it.
6. Psyche is subject to development, in the course of which quantitative changes are transformed into qualitative. The source and motive force of this development are internal contradictions.

These tenets are also determinative in comprehending the psychology of thinking. At the same time, dialectical materialist philosophy contains sections which have a special significance with reference to the psychology of thinking. These are the theory of the two levels of cognition (the sensual and rational), their correlation and interaction, as well as the theory of dialectical thinking as the highest level of theoretical thinking.

The subject of the psychology of thinking lies, as it were, at the intersection of two realms. One which falls under the competence of psychological research, and the other that provides subject-matter for a comprehensive analysis of thinking. Hence the difficulty of defining the subject's boundaries: thinking is not separated from other psychic phenomena by any rigid barrier, and the psychological approach to its study is closely interwoven with the approaches used by other branches of knowledge. In order to outline the sphere relating to the psychology of thinking we have to consider in the first place *just what* psychologists have to deal with in studying thinking. This is not a single phenomenon but one that incorporates various types of thinking. It is possible to give an initial characteristic of the psychology of thinking by describing these types. Then we shall try to define the *distinctions between the approaches* to thinking realised through individual sciences. Finally, we shall examine the *definitions* of the subject of the psychology of thinking as distinct from a comprehensive study of the latter.

§ 2. Types of Thinking

In the course of its historical evolution, psychology has gradually drawn apart from philosophy, it is therefore no accident that psychologists initially concerned themselves with those types of thinking which were originally the domain of philosophers, above all, theoretical, discursive, thinking.

René Descartes advanced the concept "Cogito, ergo sum". Leaving aside its theoretical purport and considering only its concrete psychological aspect, it is obvious that it advances thinking to the forefront in psycholife considering it symptom of human existence: nothing, in his opinion, proves man's existence as convincingly as the act of thinking. Thus, there was singled out discursive thinking, *verbal-logical* thinking. It still remains one of the basic types of thinking and is marked by the use of concepts and logical constructions functioning on the basis of language, of linguistic means. However, contemporary psychology has described other types of thinking.

Figure 1 represents an experiment involving a young child. Attached to the right arm of the lever is a toy that attracts the child making it want to reach out for it. However, the position of the toy on the table is such that it cannot be reached by simply stretching out an arm. The only way is to use the handle attached to the left arm of the lever. The child's natur-

al impulse is to pull the handle, but this only serves to push the toy farther away. To get hold of it, the child must make a movement which is opposite to the one normally made to bring a thing closer. The discovery of this mode of action, which presents considerable difficulty for a young child, is referred to as thinking in psychology. This is *visual-active* thinking, which is also typical of the higher animals. It has been analysed by Ivan Pavlov, Wolfgang Köhler, Natalya Ladygina-Kots and other scientists. The basic feature of visual-active thinking is conveyed by its name: a task is accomplished through actual physical transformation of the situation, by means of an observed locomotor act.

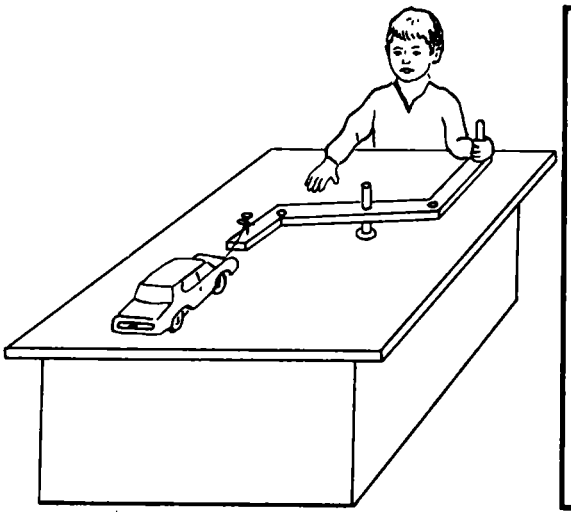


Fig. 1. Experiment studying visual-active thinking

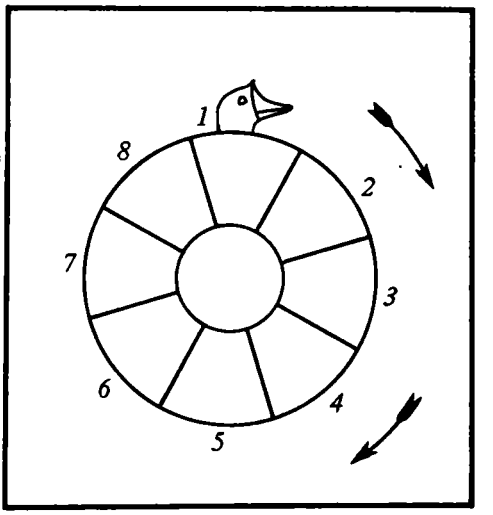


Fig. 2. A method of studying visual-image thinking

Another independent type of thinking distinguished by psychology is *image* (or visual-image) thinking. In an experiment, a pre-schooler was shown a flat figure of definite shape such as a goose cut out of plywood (Fig. 2). It was then covered by a plywood disc so that only part of it, the head and a portion of the neck, showed. The figure was then turned to a certain angle with reference to its initial position, and the child was asked to point out the place where the goose's tail was to be. Image-thinking functions are associated with visualising situations and the changes in them that one should like to effect as a result of one's activity which transforms the situation making general notions more concrete. Image thinking reproduces more fully the multiform features of an object's different actual characteristics. An image may simultaneously record the object from several viewpoints. An important feature of image think-

ing is the establishment of unusual, "incredible" combinations of objects or of their properties. As distinct from visual-active thinking, visual-image thinking transforms only the image of a situation.

Visual-active, visual-image and verbal-logical thinking form the stages of the ontogenetic and philogenetic development of thinking. It has been convincingly proved that these three types of thinking coexist in the adult, too, and function when various tasks are tackled. The classification presented above (the triad) is not the only one in existence. Psychological literature has described and made use of a number of "double" classifications.

Distinguished are *theoretical* and *practical* thinking according to the type of the task dealt with and the structural and dynamic features arising from this. Theoretical thinking is directed at the cognition of laws and rules. Dmitry Mendeleyev's periodic law of chemical elements was the product of theoretical thinking. The principal purpose of practical thinking is to prepare the physical transformation of reality: set goals and draw up plans, projects or charts. An in-depth analysis of this type of thinking was made by the Soviet psychologist B. Teplov. A most consistent study of theoretical thinking was executed within the context of the psychology of scientific creativity. A major feature of practical thinking is that it unfolds when there is an acute lack of time. For example, for the fundamental sciences it makes very little difference whether a certain law has been discovered in February or in March of the same year, while a plan of combat operations drawn up after the event renders the work meaningless. Practical thinking offers very limited opportunities for testing the hypotheses, which thus makes practical thinking even more complicated than theoretical thinking. The latter is sometimes contrasted with empirical thinking. The criterion used to distinguish between them is the character of generalisations; in one case, these are scientific concepts, and in the other, situational generalisations made in the course of daily life.

Distinction is also made between *intuitive* and *analytical* (logical) thinking. Three criteria are used as a rule: the temporal (the time of the process's duration), structural (division into stages) and the level of the process's development (awareness or lack of it). Analytical thinking evolves in time limits, has clearly defined stages and is, to a considerable degree, represented in the thinker's consciousness. Intuitive thinking is characterised by speed of the process, lack of clearly defined stages and minimal degree of awareness.

Thinking in psychology is also divided into *realistic* and *autistic* thinking. The former is directed mostly at the outside world and is regulated by the laws of logic, while the latter is associated with imaginary fulfilment of a person's wishes (all of us have indulged in wishful thinking). The term "egocentric thinking" is sometimes used; this type of thinking is marked, above all, by inability to accept another person's viewpoint.

It is important to distinguish between *productive* and *reproductive* thinking. This differentiation rests on the degree of novelty marking the product of thought activity with reference to the subject's knowledge, and on how pronounced are the psyche formations incorporated in the structure of activity (motives, goals, meanings, appraisals, attitudes).

Types of thinking are sometimes distinguished on the basis of differential-psychological characteristics (*flexible* and *rigid* thinking, *impulsive* and *reflexive* thinking, *critical* and *persuadable*, *broad* and *narrow*, *new* and *old*), as well as to features of the object-related sphere which it embraces (*technical*, *economic*, *political*, *scientific*, *religious*, *everyday* thinking). Also distinguished is *psychological* thinking proper, which is directed at the psyche and mentality of a concrete individual, and at cognising psyche at large. Psychological thinking may be theoretical and practical, logical and intuitive, creative and non-creative. Characteristically, the word "psychologist" has at least three meanings: the scientist, the artist, and the practical worker.

One should distinguish between *involuntary* and *voluntary* thought processes: for instance, the involuntary transformation of images in one's dreams, and purposeful work to solve a thought problem.

This list of classifications is not complete. Types of thinking are connected by complex links which have not yet been adequately analysed. However, one thing is clear: psychology uses the term "thinking" to denote qualitatively differing processes.

§ 3. Sciences That Study Thinking

Thinking is the object of complex, interdisciplinary studies. The basic question of philosophy is formulated as the relationship between being and *thinking*. The very term thinking is used in philosophical literature to convey a broad range of meanings, sometimes as a synonym for consciousness and at times for "spirit", i.e., psyche. Philosophy concerns itself with the more general issues: what is primary, matter or thinking (the answer to this question divides the materialists and the

idealists); can the world be cognised through thinking, and if it can, how does cognition proceed? In drawing a dividing line between the realms of philosophy and psychology, of most importance, evidently, is *whose* thinking provides the object of research. Philosophy views thinking as, above all, a social and historical process, as the historical development of man's cognitive abilities, as his genetic feature, whereas in the concrete psychological context, the accent is on the thinking of individuals conditioned, of course, by historical development. Philosophy (the theory of cognition) is most interested in the final product of man's cognitive activity (can it be regarded as the reflection of the outside world?). As far as psychology is concerned, the object of interest is the very process by which these products, the end results of thought activity, come into being.

A major question is that of differentiating between the formal-logical and the psychological aspects in the study of thinking. The object of formal-logical study are the basic "forms" of thinking: concepts, judgements and inferences. Singling out, systematising and classifying these forms constitute a major aim of such research. As distinct from psychology, logic concerns itself, first and foremost, with sound, genuine thinking. Psychology studies the actual process of thinking, which is not always represented as "sound". A psychologist is interested not only in the instances when a person adequately reproduces an object's real features in his thinking but also in those cases when the object is ascribed features which it does not actually possess. What is more, psychology studies distorted, impaired thinking which is a symptom of certain diseases. An analysis of thinking lies within the scope of such branches of psychology as neuropsychology and pathopsychology. The notion "error" can hardly be applied to describing the search for a task's solution: what is "erroneous" as regards the end stage very often fulfils a rather useful preparatory function.

The sociological aspect of the study of thinking is closely linked to the philosophical, and is directed at analysing the historical development of cognitive processes as determined by the social structures of the various social formations. Directly related to the study of thinking is the study of science (the science of science), which gives a tangible aspect to the approaches typical of the theory of cognition at large and of sociology as related to the specific field, scientific activity. It generalises the supra-individual laws of science's development, whereas psychology studies scientific thinking also as the thinking of concrete individuals.

A great deal of research into thinking has also been carried out, particularly in the 20th century, within the framework of the natural sciences. The physiology of higher nervous activity reveals the dynamics of nervous processes with the aid of which acts of human thinking are realised. Just as other psychic functions, thinking is a result of brain activity. These brain substrata, brain mechanisms, are studied by the physiology of thinking. A distinctive branch in the physiology of higher nervous activity has been outlined, which is most closely connected with the problems involved in the psychology of thinking, the teaching of the two signalling systems. A physiologist is concerned, most of all, with the dynamics of nervous processes, through which the functions of thinking are fulfilled, whereas a psychologist can disregard this dynamics and concentrate on the structure of thought activity, its dynamics, conditions of origin and disruption, this being a relatively autonomous task. The range of concepts which the thinking of a given individual employs is determined not by the properties of his nervous processes but the conditions under which these concepts are assimilated, the conditions of man's life and activity, the differences in the cultural background. Thus, one and the same nervous substratum, conventionally speaking, can provide the background for totally different psychological thought processes. Therefore, psychological analysis is *relatively* independent of physiological analysis.

Recently, thinking has also been studied extensively by cybernetics, the information (computer) science and under the artificial intelligence theory. The latter term is used to denote a branch of science which has the goal of reproducing man's thinking by means of the computer. The psychology of thinking has become connected with the theory of algorithms, the set theory, and the general systems theory. Cybernetics deals with thinking as an informational process and records common aspects of a computer's work and of man's thought activity, whereas psychology researches the specific characteristics of thinking, its distinctions from the informational processes carried out by computers, and the specific ways in which thinking is affected by informational technology, concepts and methods of the science of information.

§ 4. The Psychology of Thinking: Definition of Subject

The traditional definitions of thinking usually pinpoint two features: generalisation and mediation. These two character-

istics distinguish thinking from perception: the concept of the "table" differs from my vision of the table; I *see* that the roof is wet and infer that it has recently been raining. These characteristics are indeed important, but they do not differentiate between the theoretical-cognitive, the logical and the psychological approach, and for this reason, definitions of this type may be viewed as a definition of the object of the comprehensive study of thinking.

Let us formulate the tenets which characterise the psychological aspect of the study of thinking.

The first is of the polymorphous quality of man's thinking, which points to the diversity of its types. It necessitates the consideration of this diversity and stresses that it cannot be reduced to theoretical, verbal-logical thinking. A psychologist engaged in the study of theoretical thinking alone would substantially restrict his task.

The second point is the common features typical of the external practical object-related activity and the theoretical, thought activity in its narrow sense. This tenet is of great importance, although, of course, the subject-matter of psychological research is not exhausted by it. Contained here is a major methodological principle, i.e., to examine, within man's thought activity, all the structural formations which originally and traditionally have been singled out as non-thought activity, as object-related practical activity. In a word, a psychologist should make a special study of the motivation of thought activity and draw some distinction between activity, action, and operation, similar to the manner in which external object-related practical activity is studied.

These points, in fact, prompt one to single out a certain sphere that is subject to psychological study proper, a concept that has been substantiated in Soviet scientific writings. In the opinion of Sergei Rubinstein, as projected in his work *On Thinking and Ways of Its Analysis*, thinking as the principal object of psychological research is presented as a process, as activity. The idea of thinking as a process, an activity, differentiates thinking from its products, from that which, so to speak, is a result of the thought process. Rubinstein obviously referred to the task of drawing a dividing line between the interests and domains of psychologists and specialists in the fields of logic, sociology and the theory of cognition. He discussed thinking as an individual process that takes place in an individual's brain. This definition of the study of thinking as a process, as activity, separates the two terms with a comma,

i.e., does not correlate them. It is implied that thinking proceeds in time and consists of certain phases, or stages, with a beginning, an intermediate stage and an end. Thinking is directed at reflecting the outside world and is an expression of the subject's activity. In this sense, thinking is always subjective, even when it reflects the outside world correctly and adequately.

Another point of view in respect to the subject of the psychology of thinking as an independent one has been developed by Pyotr Galperin in his work *Introduction to Psychology* (in Russian). Its author interprets psyche as a form of orientating-research activity and insists, with good reason, that psychology is not the only science studying psyche. He noted: "Psychology studies not merely thinking and not all thinking, but only the process of the subject's orientation towards thinking when dealing with intellectual problems." Thus, there are two versions, two interpretations of the subject of the psychology of thinking, and the task is to find what they have in common. This unity can be reduced to the following four points:

1. The need to single out the special aspect of the study of thinking by psychology, and the rejection of attempts to relegate all types of thinking to the competence of psychology.

2. An emphasis on thinking as a process, i.e., its progress in time and dynamics.

3. A somewhat loose usage of the terms "process" and "activity". Sergei Rubinstein points to "thinking as a process, as activity", while Pyotr Galperin refers alternately to the orientation process and orientating-research activity. Orientating as a process and orientating as activity are also used interchangeably more often rather than to distinguish between two different phenomena.

4. Recognition of the fact that thinking and orientation are executed by the subject. This subject-related nature of orientation, of activity, must be taken into account by the psychologist. At the level of logical analysis, it is both possible and often necessary to dissociate oneself from the subject, while at the level of psychological analysis this should not be done.

These definitions of the subject of the psychology of thinking single out a certain slice of reality which is subject to psychological study. They can still be used as working definitions, that do not claim to be exhaustive. However, one should immediately note that they have a somewhat vulnerable point: they do not decipher the process, activity or orientation. This imparts to them a wide range of possible interpretations. Therefore,

while continuing to use these terms, as basic, working concepts, recent research into thinking has concentrated, to a large extent, on elaborating more detailed and psychologically meaningful definitions of these terms. However, since it is impossible to raise the results of all research to the level of definitions of the object of psychology, we still retain these definitions stipulating that the ideas of process, activity and orientation are changing and are used in a variety of senses, and that new meaning is being added to them. Thus, it has been shown that orientating is selective when dealing with sufficiently complicated tasks, and is spontaneous and original when creative tasks are tackled. On the other hand, today it is not enough to describe the process of thinking as the interaction of analysis and synthesis; it also incorporates dynamics and the production of meanings, goals, evaluations and needs. For now, we shall accept the following working definition: *thinking* is a process, cognitive activity, whose products are characterised by a generalised and mediated reflection of reality. Certain types of thinking are singled out depending on the level of generalisation and the nature of the means employed, on the novelty of these generalisations and means for the subject, on how active the subject's thinking is.

§ 5. Methods of the Study of Thinking

Just as with any other psychic phenomenon, there is only one approach to a psychological study of thinking, i.e., objective research, no matter how difficult it may be. Attempts to employ introspection as a method of research into the psyche have also failed in this branch of psychology. Objective analysis of thinking demands that those external conditions which give rise to thinking and affect its progress are discovered. For example, the characteristic features of the *task* facing man substantially affect his activity. This influence is, of course, also determined by the internal condition of the activity. Objectivity of the study also requires that those features of activity are carefully noted which reflect man's thinking in one way or another, which allow us to judge just how thinking proceeds: the very fact of the task's solution, the type of solution, the time needed to find a solution, spontaneous utterances in the course of looking for solution, thinking outloud, peculiarities of psychophysiological reactions. The psychology of thinking makes extensive use of all basic methods of collecting empirical material.

Observation. At first sight, this method seems to have nothing in common with the study of thinking. However, this is not so. Observing man's actions in different life situations, his mimics and pantomime in dealing with a task, and the way he associates with other people, a great deal can be learned about his thinking. Thus, in observing a child doing his homework, one can note how regularly he has to deal with the type of task set before him, how much time he spends accomplishing it, and what the results of his efforts are. This sort of observation may form the basis of judgements concerning the child's attitude to his work, which affects the solution of concrete tasks, the degree of organisation of his mental activity and the degree of maturity of his mental skills. Watching a pre-schooler at play, one can understand the type of games he prefers and express the supposition as to how far advanced his image thinking is. An intensively working and sufficiently experienced researcher can often be seen amidst a large number of dictionaries, thesauruses and reference books. This feature reflects the sphere of knowledge which is involved in the search for a solution to a concrete problem.

In all of these cases, thinking manifests itself spontaneously and naturally. As in the study of other psychic phenomena, the observation is purposeful and planned, and its results are noted, e.g., the sequence of solving (or failure to solve) the tasks and the minutes of oral discourse. At present, the psychology of thinking makes broad use of technical means (photography, films, sound recording, etc.) As in other branches of psychology, observation as a method of research into thinking has both advantages and drawbacks: on the one hand, the activity proceeds under natural conditions, but on the other, it is not always easy to assess the significance of some conditions or others for the emergence of the phenomenon under examination (e.g., the appearance of a problem situation). This drawback is partly made up for by long duration of observation.

The *experimental method* is quite extensively employed in the study of thinking. It makes possible the active reproduction of the phenomenon in specially created conditions. This also makes it possible to more clearly reveal the factors affecting the progress of the thought process, to repeatedly reproduce the conditions of study and thus accumulate statistical data, and to vary the conditions thus exposing the cause-and-effect relationships. An example is the formation of artificial notions (in a variety of modifications), as well as the experi-

ments involving the use of prompting in solving intellectual problems that require conjectures and surmises.

Experiments can be either *natural* or devised in *laboratories*. Essentially, a natural experiment is a situation in which new educational methods are being introduced, or new instruments are used in scientific research. Although differing in many aspects, these situations have one feature in common: they provide conditions for substantial changes in thought activity. Particular variants of "natural experiments" are illness and impairment of brain activity, which produce considerable changes in man's thought activity.

The psychology of thinking is making fairly wide use of the "experimental-clinical" method, which combines experimental (reproduction in laboratory conditions, the use of instruments) and clinical (a detailed analysis of individual cases) features. It has proved possible to thoroughly examine the processes involved in the formation and resolution of tasks by testees (subjects), with the polyregistration of the objective indicators of the developing processes (eye and locomotor activity, oral discourse, vegetative reactions). In staging an experiment, one must take into consideration the testee's reaction to the experiment, and his relations with the one making the experiment.

Laboratory and natural experiments are divided into formative and recording ones. The former are subdivided depending on the aim towards which the formative procedure is directed: be it the operational and technical aspect, or the need-motivational.

Interview. The method makes it possible to reveal the testee's attitude to the task he is tackling, his idea of his own mental processes (reflection), and his evaluation of his mental abilities (self-evaluation). Of interest are both the answers to direct questions (Are you acquainted with the task offered you?) and indirect questions (How do you perceive this task?). Projective questions are also used (This task is usually viewed as a familiar one, isn't it?). It is important to understand just how suggestive the questions are. An important factor securing the testee's active participation in the interview is the establishment of a relationship of trust and understanding with the researcher. The interview is always supplemented by observation of the testee. Psychological writings define the interview as an auxiliary method used to verify the data yielded by observation and experiment, as well as for primary study of the testee. Investigation of thinking also makes use of questionnaires: the so-called open questionnaires, in which the person who is questioned

must fashion the form and content of his reply himself. They prompt him to think more actively than closed ones, but are more difficult to process statistically.

Analysis of the products of activity. With reference to thinking, this means not only the analysis of oral or written verbal products (diaries, letters) and verbal-image products (sketches, charts) but also of concrete objects (machinery, instruments, installations), and a study of the history of inventions and discoveries.

Testing reveals individual characteristics of thinking (intellect). The first large-scale tests involved precisely intellect. Not only tests assessing abilities and skills but also achievement and projective tests can be used in the study of thinking. This is so because, first, thinking is always subjectively conditioned, and, second, thought operations, at the level of both images and concepts, are always involved in performing projective tasks. Vice versa, tasks necessitating an intellectual effort are frequently employed to reveal the testees' personal traits. In the study of thinking, testing has gained wide currency in differential psychology.

Both qualitative and quantitative methods are used in the study of thinking: factor analysis in investigating the structure of intellect, correlational analysis when dealing with the dependence of thinking on man's individual psychological characteristics, informational analysis when forming artificial concepts, the multiple scaling methods in studying the emotional regulation of thinking. Methods of mathematical and programme modelling of thinking are also being developed.

Each of the methods used in the study of thinking has its strong and weak points and its limits. Thus, specialised writings always contain a fair amount of criticism directed at each of these methods. For instance, laboratory experiments are reproached for being artificial and setting rather easy tasks for the testees. Indeed, the testees are not expected to make a discovery or invention, but, for example, to connect four points. The way out of these truly existing difficulties is to combine different methods employed in the study of thinking, as well as to use such model tasks that can be employed under laboratory conditions but are at the same time, as it were, fragments of real life activity. In this sense, game tasks have proved useful.

Proponents of formative experiments frequently underestimate the importance of recording experiments. In fact, any formative experiment necessitates verifying what has been achieved and establishing the relationship between the results of

the formative experiment and the goals set by the person conducting the experiment.

Contemporary writings still tend to overestimate the importance of statements made by distinguished scientists and inventors concerning their work. These statements, important and interesting though they are, must still be viewed as auxiliary, secondary material which throws light on the standard of self-awareness of the subject of thinking. In fact, psychologists have to deal with the double product of the thinker's activity, his theory or invention (the solved task), and his idea of how this had been achieved. The double quality of this product reflects the psychological structure of man's thought activity. With respect to self-awareness (reflection), one must also distinguish between the product of reflection and the process of reflection. Reflection about thinking is not necessarily adequate even in the case of theorists. Certain philosophers are held responsible for spreading the "myth" that scientists with the help of two separate, well-trimmed and standardised methods—the deductive and the inductive—can approach any problem of knowledge.

The great diversity of methods used in the study of thinking also gives rise to a differentiation between the types of psychological research into thinking.

Chapter Two

THE OBJECT AND SUBJECT OF THINKING

§ 1. A Task as the Object of Thinking

Thinking often evolves as the process of solving or resolving a task. Tasks may relate to the sphere of nature, public life or man himself, his thinking. Tasks may arise in the course of engaging in some practical activity (for example coming up against an obstacle) or may be deliberately created (educational tasks, game tasks). In both cases, the task is the object of man's thought activity (as a rule, this is not an individual object but an object-related situation). The task has a definite objective structure, with one of the parameters being its complexity. The features of the structure of the task affect (in more than just one way) the activity involved in solving the task. This means that a psychologist must reckon with them, for they are a component part of the determinist analysis of thinking. The fact that some tasks are easily solved while others present certain difficulties (other conditions being equal) is well-known. However, no attempt has practically been made to discover why this is so.

Let us consider one of the more developed and segmented objects of thinking: the deliberately created task. Distinguished in it are the *requisite* and the *conditions* which determine the ways of meeting this requisite. For instance, "Masha and Katya each have five apples" (condition); "Find out how many apples they have together" (requisite). Describing the conditions which determine the activity necessary to solve the task, the following characteristics are as a rule employed: 1) "familiarity-unfamiliarity" of the situation (this characteristic determines the scope of orientation in a situation, the ability or inability to reach the desired result by ready-made means). 2) The nature of the task that has been set (verbal description, graphic representation, a real situation). 3) The degree to which the "essential relation" is pronounced in the

situation. This is the key factor in finding a solution. Implied by the idea of the task are the indirectly defined intermediate strategic and tactical goals, which must be set and attained in order to arrive at the solution known to the person who has created the task.

The experience of creating artificial tasks has given rise to a number of requirements set to the task and the idea of its solution:

a) the solution and the idea must be concealed. To do this, a paradoxical first step is introduced which contradicts the rules of conducting the given type of activity and produces the impression of deviating from the solution. Occasionally, the so-called "false trail" is introduced, an action which seems strong and effective but which in fact fails to lead to the solution.

b) the solution must be dynamic and bold, with both sides acting vigorously;

c) the idea must be original;

d) the task must meet aesthetic requirements.

Essentially, all methods of disguising the solution can be reduced to giving the person working on the task as little opportunity as possible, in the initial position, to find the landmarks pointing to the way of solving it.

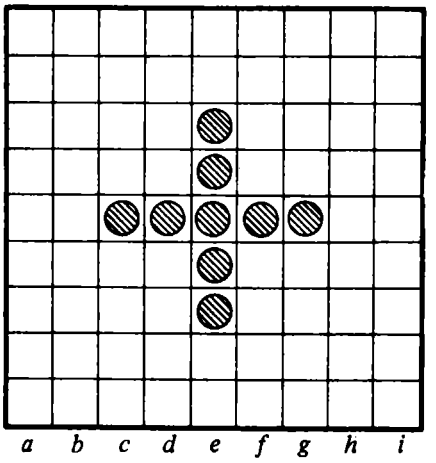


Fig. 3. A puzzle used in psychological experiments

A good example of deliberately created tasks are the various puzzles. Let us dissect the checkers puzzle represented in Figure 3. Apart from the conditions of the task, which in this case are presented graphically (this circumstance places the task in the domain of visual-image thinking) and the requisite ("to leave a single draught in the centre of the field"), its structure comprises the rules of situation transforming ("moves", actions, operations). They regulate the move of the draughts (a draught can move only onto an empty square and only across another draught) and the result of this move (the draught that has been moved finds itself on another square; the draught across which another one has been moved is removed from the board). The terms of the task may restrict the number of transformations and the time allotted for them (in the task under consideration,

such restrictions are absent). Often, the rules of transforming the initial situation are taken as known, and then recognition of the type of task (an arithmetic sum, a geometric or a chess problem) is already sufficient for deciding upon an adequate systems of operations. In this case, the rules are not mentioned when formulating the task. Let us now consider the conditions of the task and their parameters that can be singled out.

These are, above all, *elements of the situation.* It is easy to see that the situation consists of a set of individual elements. In this case, they are the squares of the board and the draughts. The number of occupied and empty squares may be indicated. The draughts, just as the empty squares, form a certain pattern. The elements of the conditions may correlate in a variety of ways. Among them are spatial relations (far—near, on the left—on the right) and functional relations. Let us consider the latter in greater detail, since they have special significance. These relations are determined by the accepted *rules of transforming the situation.* We shall examine several types of functional relations: "to allow the neighbouring draught to make a move", "to prevent the neighbouring draught from making a move", "to prepare a possible move", "to preclude a possible move", "to obstruct a possible move", "to take a draught by the next move". The system of spatial and functional relations serves to reveal the situational properties of each element, the system describes the situation viewed as a whole.

To solve a task (in artificial tasks, the solution is always known,) often means to choose a certain element out of many, and to choose a definite action to be performed on this element. A characteristic of the situation that may be described as objective freedom of choice arises (the number of one's own draughts and the number of possible moves), from which a choice may be made. In the initial situation of our task the solution may be begun by moving one of the four draughts, each of which can be moved only in one direction. To attain the final result, a varying number of intermediate acts (in our case, eight moves) may be required. In the process of executing the intermediate acts, which lead to the attainment of the final result, the situation may change. Thus one may have to make each next move under conditions that will differ from the initial ones. The situation changes may be of two types: dependent only on the person solving the task, or independent of him. In our task, we have to do with the former, while the latter type is typical of playing against an opponent.

The pre-set *range of choices* available for transforming the situation is characterised by the number of correct ones, i.e., those producing the desired result (one or several; in the latter case, the choices are distinguished depending on their effectiveness). In our case, there are four equally effective choices. In principle, the number of choices may be nil (a task with no solution) or virtually endless (in the so-called open tasks). Digressing from our task, we should like to note that the changes in the situation that do not depend on the person solving the task may be directed at making the solution as difficult as possible (the opponent's defence). It may also be marked by a great diversity—the choices posed by the changes in the situation independent of the person solving the task. Independent changes of the situation may either obstruct the attainment of a result, or define the concrete way of reaching it after these transformations. Thus the result may be attained in any independent situation change, but each time in a different way depending on the individual change.

The *changed situation* can be characterised by all the parameters applied to the initial situation, but their value may change. Other factors subject to change are the number of situation elements, their qualitative composition, the nature of their interaction, their objective freedom of choice, and the number of possible solutions (one or more; the task may also become insolvable). Take our problem. After the first move e4-e2, in a changed situation, the number of the remaining moves is four, three of which make the task insolvable. The *final situation*, i.e., the one that has emerged after all dependent and independent transformations of the initial situation, is characterised by the degree and concrete form of participation of each element of this final situation in attaining the result.

Each concrete *element of the situation* has a definite objective value which is revealed in the system of this element's interaction with the others. For instance, in the initial situation of our problem, the draughts d5, f5, e6 and e4 can move, whereas the draughts c5, g5, e7 and e3 cannot but may "fall victim" to the moves of their neighbours. A change in conditions may produce a change in an element's value: draught d5 loses its ability to move on square b5. Consequently, it is necessary to differentiate between the values of the same element in the initial and the transformed situation (with reference to each of the transformed situations). Each individual element may perform a variety of functions in a given situation (draught d5 moves to square b5 and prepares a possible

move for draught e5) and, consequently, have different values. At the same time, one and the same element may perform several functions simultaneously, thus the concept of the element's functional load (sometimes the concept of "purity of goal" is used). In characterising value, one must distinguish between the values acquired by the element under certain transformations of the situation. This value may be either obvious or hidden. This means that the transformations of the situation, i.e., the consequences of a move, may be divided into obvious and hidden.

Functional interactions occurring in a situation vary in their significance, and the same is true of situation changes. Thus, such parameters as a "weak" or "strong", "good" or "bad" situation change. There are at least two different sources of creating value: a) by referring to the final result (whether the change promotes its attainment or not); b) by referring the change in the situation that is underway to a definite type, to the general principles of performing a given type of activity, the degree to which this concrete situation change embodies the general principles (which have themselves acquired a positive value), i.e., through the relation, as it were, to values of a higher order. The values of one and the same transformation of a situation defined through this twofold system of relations may correlate in a variety of ways: they either do or do not coincide and even clash. For example, a specific action, a transformation of the situation may be "weak" when related to the general principles of performing a given type of activity but "correct" when related to the final result (or vice versa). The clash between various values places this kind of task into an independent category.

In our case, the conditions of the task are "artificial" i.e., created by someone other. As a product of his conscious activity, they embody (exteriorise) a certain idea (the idea and content of the task). The same idea may find expression through a variety of means. Thus, the characteristic of the form in which the idea is expressed. The author's task continues to exist independently of him, and the same is true of the idea. The idea is a certain possible transformation of the existing situation, the establishment of a certain interaction. Without the latter, the task cannot be solved (the result is not attained); it is precisely this interaction that the author of the task had in mind in creating it.

The ideas behind the task may differ depending on the kind of functional interaction that has been chosen by the author.

The idea assumes definite shape through its relation to a definite type of interaction (and can be recognised as such in dealing with the task). This basic interaction may be established as a result of transforming the initial situation, as a result of independent changes in the situation or after all the transformations have been accomplished; it characterises the final situation in which the goal or result is achieved. The basic interaction may be established through a sequence of situation changes, or in the course of a variety of alternative changes. The different types of basic transformations are grouped depending on their relation to the various general principles of performing a given type of activity. The basic transformation of the situation and its direction may be deliberately disguised. In our task, the idea of the author is to "disguise" the possibility of a leap across draught d5, since in the initial situation it is simply impossible.

The conditions of the task may be described verbally, be immediately perceivable (objects and their pictures), or be represented.

Thus we see that the conditions of the task have a number of characterisation levels, which should be considered in analysing the process involved in resolving the task. Perceiving, understanding and memorising the conditions of the task may cause greater or lesser difficulty, be more or less complete and adequate, and provoke a variety of attitudes on the part of the subject tackling the task.

One should recall that the structure of the task comprises not only the conditions but also the requisites. As a rule, the latter are described verbally. Two types of requisites can be distinguished. In the first case, this is the indication of what the situation ought to be after the initial situation has been transformed. In our case, it is "to have just one draught left on the board". "One draught" is in fact the description of the final situation. In the second case, the requisite refers to getting new knowledge as a result of performing certain operations over the conditions: "Katya has two apples, and Nina has three; how many apples do they have together?" "Seryozha is taller than Kolya, and Petya is taller than Seryozha; who is the tallest?" In this instance, a question relating to the task should be formulated, which is essentially an equivalent of the elaborated requisite (to find out, to discover): "To find out how many...?" A major characteristic of a requisite is the degree of precision (or lack of precision) in formulating it. Let us compare two definitions relating to our task: "to leave one

draught on the board" and "to leave one draught on the board in the centre". In the first case, the possible interpretations of the requisite may vary within a certain range, with each being formally correct: "to leave a draught in the centre", "to leave a draught on the left side", "to leave a draught on the right side", etc.

A task is also characterised by the correlations between the conditions and the requisites: all elements of the conditions are necessary for solution (as is the case in our task); there are superfluous elements (visualise a board of 64 squares); essential elements are absent (remove draught d5 in the initial situation, and the task will become unsolvable).

The correlation between the conditions and the requisites may also be described using the "modality" of their description as the basis. In the task analysed above, the conditions are presented in pictorial form, while the requisites, as a verbal formulation.

The significance of giving due consideration to the task's objective structure may be illustrated using chess problems as an example.

Several series of experiments have been staged which differed by the type of task set before the testees. The first series had two problems involving the same pieces having a very similar spatial position (identity is impossible), but with different *ideas* behind the tasks ("self-restraint of the black pieces" and "simple pinning down"). It has turned out that the average time in which each of the ten testees solved the problems varied within the range of three units. In the oral report, eight testees evaluated one of the tasks as the more difficult, an opinion that was confirmed by the fact that they spent more time solving it. All replied in the negative when asked whether the tasks were similar.

The second series of experiments involved two problems featuring the same number of elements, having the same idea but involving pieces of different value and with a different spatial location (different form). The average time was 38 and 20 minutes. Thus it was shown that tasks with the same idea behind them may present entirely different difficulties for the testees. The data obtained as a result of these two series of experiments demonstrated that neither the idea nor the form of the task are the determinants of the difficulty of its solution.

The third series varied the tasks according to the "difficulty presented by the first move" (this characteristic was worked out by experts or borrowed from literature on the subject). It turned

out that an average of 18 minutes was required to solve the problem with a difficult first move, and 6 minutes, with an easy first move, with no connection existing between this characteristic of the problem and the rest. Of course, what we have here is only a tendency, since some problems with a "difficult" move may be solved faster than those with an "easy" move. This points to the fact that the characteristics formed by "an expert" and the testees' subjective evaluations do not always fully coincide. The fourth series also featured problems differing as to the first move (to verify the results yielded by the third series). The average time of solving the two problems was 21 and 48 minutes. The second problem took 39 out of 40 testees longer to solve than the first, and most referred to it as the more difficult in the oral report.

The research described above has shown that, knowing the complex structure of the task and its conditions, it is possible to deliberately vary the elements of this structure in order to analyse their effect on the activity aimed at solving the task, analysing, for instance, such a parameter as the "degree of difficulty". The data received has shown that the difficulty encountered by a person in dealing with a task arises not only from purely subjective factors, which, naturally enough, are of great importance (attitude, the standard of training, etc.) but also from objective ones, the structure of the task and its complexity. The effect of the task's structure is manifested in the fact that while the absolute time needed to solve a problem by testees with different levels of skill and with the same levels of skill varies considerably, the average time needed to solve one problem differs greatly from the average time needed to solve another. All characteristics of the task's conditions may, to a varying degree, contribute to its complexity, but the principal factors can be distinguished here. Research has shown that the basic source of a task's objective complexity (at least this is true in the case of games) is the presence of a conflict between the different values of one and the same transformation of the situation (a "light" move crippling the position, a "false trail", etc.). The number and composition of the elements of the task are not among the leading factors (a task featuring the same or even a smaller number of elements may take more time to solve). Experiments have shown that the tasks which necessitate a certain basic transformation of the same type (tasks with the same idea behind them) may vary as to the time spent to solve them. This is also true of the tasks in which different transformations are accomplished under very similar initial conditions.

Let us now return to a task's requisites. "Rigidity" of the wording is sometimes used as a differentiating criterion in describing the differences between construction and construction-technical tasks.

In creating an experimental situation, seeking to imitate the conditions that secure an invention, psychologists have offered the patent for an already registered invention to a number of workers as a precisely formulated task with a clearly defined range of conditions and requisites. As distinct from the natural course of developments leading to an invention, the answer was, in this case, known to the experimenter beforehand and he could vary the conditions of the task, map out questions and do some prompting. Other researchers, however, placed in question the assumption that the situation engendering an invention or a discovery is preserved, believing that in using the patent for an already existing invention as an experimental task, the experimenter himself unwittingly offers the testee a task in the final stage of its transformation when it is clearly patentable and, essentially, lacks that structural complexity which demands an effort of sufficiently high complexity. In actual fact, when an invention is being made, such an essentially controversial, zigzag search never produces a *single* solution, as is usually assumed in the wording of a patent or in the bulk of the writings devoted to problems of inventing.

For the most part, psychological literature develops the typology of tasks with reference to educational tasks. The following parameters are usually distinguished: the logical accuracy of posing the task, how definite it is, the level of generalisation, how full the exposition is, complexity and difficulty, and problem value. Another classification has also been evolved; tasks with indefinite initial data, indefinite exposition, superfluous or unnecessary initial data, contradictory information under conditions which make possible only tentative solutions, with limited time allotted for the solution, and necessitating the use of objects in an unusual capacity, and finding an error in the solution.

Tasks vary as to their scope. "To preserve life on earth" is a global problem. The scientific community has recently begun to talk of the need for a special science dealing with problems, problemology. This is further proof of the significance of studying problems as developed objects of man's thinking.

A hierarchically arranged sequence of tasks forms a programme of behaviour. Such programmes are being thoroughly examined within the context of the psychology of scientific

creativity. One can also refer to the life programme of a concrete individual.

§ 2. The Subject of Thinking

Following a concise characteristic of the task, we turn to the person solving it, i.e., the subject. If one is to define the basic, decisive condition which initiates and promotes the process of solving a task, this is, above all, an act of accepting the task. Suppose we have charted a task on the blackboard. However, if some of those present are engaged in more important things, such as preparing for a foreign language class, translating a text, then no matter what we have drawn, it will remain just a drawing or a chart. Our task will not become the task of the subject.

What exactly is an act of acceptance of a task? It is linking it with a certain motivational structure that already exists, has been actualised in a given situation, or is being deliberately created.

Motivation is the principal characteristic of the subject of activity, the main source of his activeness. This point, which seems self-evident, should be specially noted, since it is the need to actualise the motivational structures as a condition of the activity aimed at solving the problem that is often overlooked in discussing thinking and problem-solving. The usual reference is to the operations which unfold as the task is dealt with and the levels at which these operations unfold. However, the most important thing is ignored: until the task has been accepted, nothing will be done to solve it. Consequently, in discussing the subjects solving a problem and not the task that is to be solved, we must give a concise exposition of what motivates the thought activity needed to solve the problem. "No one can do anything without at the same time doing it for the sake of one or other of his needs," wrote Marx and Engels. This statement is quite applicable to thought activity. That which serves to meet a concrete need, through which it is made concrete, is referred to as motive.

Psychological writings usually single out two groups of motives of thought activity: external and internal. These terms are, of course, neither completely accurate nor exhaustive. However, their meaning is as follows: external motivation implies that the task is being tackled to attain results that are not connected with cognition of the object, of some disguised, veiled properties of the situation itself. For instance, to solve

a problem in order to leave as soon as possible if it has been stipulated that those who have solved the problem may leave. At least part of the group working on the task would have external motivation actualised.

The same problem may be dealt with based upon internal motivation, which would include such aspects as finding out what the given problem is like, the method of solving it, and the relationship between solving this type of problem and dealing with the more general questions of the psychology of thinking. This is a complex of purely cognitive aspects. Let us visualise a situation which stipulates that the person who is the first to solve the problem may leave the room. But there are already several people who have finished, yet they have not left. Additional questions arise: is there a similar problem used in psychological experiments? Can one bring his friends who would work on their problems? Similar indirect indicators show that a certain cognitive need has become actualised.

Motivation is a sine qua non for generating thought activity necessary to solve the problem, but it can have different forms. At one pole is external, and at the other, internal motivation. The concepts of these two types of motivation have become more or less settled in scientific writings. A more subtle question that arises here is whether thinking can be initiated only by external motivation. Can it develop on the basis of external motivation alone? The matter is that a task, if it is of an intellectual nature, and not one presupposing mere application of ready-made cognitive patterns, always contains a stumbling block (in puzzles, it is deliberately arranged). One comes up upon a snag. As soon as this happens, a new need that did not originally exist, is actualised. A person begins to tackle the task proceeding solely from external motivations, such as to leave the room as soon as possible, or not to give people reason to think that he does not know how to solve such problems (defence motivation). But when he has set about the task and come up against some difficulty, he feels the need to find out what it is that prevents him from solving the problem, and how to circumvent the obstacle. This means that additional analysis is needed, and hence needs, motives are actualised in the course of solving the problem. They are, as it were, added to the original motives.

The activity aimed at solving a problem always has polymotivation. A subject is characterised by a variety of motives which form a hierarchical structure, and therefore the act of accepting a task means linking it up with a whole group of mo-

tives. When we analytically single out any one motive which forms the foundation for the solution, we are forced to recognise at the same time that as the solution unfolds, this initial motivation "becomes overgrown" with additional motives, and the activity becomes polymotivated.

But does this mean that the traditional subdivision into external and internal motivation is senseless? Not at all, because even within the structure of polymotivated activity, the share and importance of the various motives may vary, and the cognitive motives actualised in the course of attaining a solution may be relegated to secondary roles. In such a case, we may be justified in saying that this activity itself is motivated, above all, externally, but with the proviso that external motivation is amplified by internal motives. The same is true of internal motivation, which may dominate right from the start. Nevertheless, this does not mean that secondary, auxiliary circumstances forming external motivation may not perform a certain role in organising activity, in solving problems.

Actualisation of a new cognitive need in the course of looking for a solution is associated in psychology with the emergence of a problem situation. Why do psychologists sometimes draw a dividing line between a task and a problem situation? It is because the task which is to be solved and has been accepted by the subject may at first seem easy to him, may appear to be one that does not call for any resourcefulness and, indeed, is solved initially using standard ready-made methods. The task presented in Figure 3 which we have analysed in detail ends in a blind alley after the moves d5—b5, f5—h5, e6—e8 and e4—e2, which seem "natural". There are no moves left, while the number of draughts on the board is still five. There emerges here what is referred to in psychology as a problem situation. Its basic feature is failure to attain a solution by applying previously used methods and means. Viewed from the angle of need and motivation, a problem situation is nothing but actualisation of a new cognitive need: "What should I do next?" "How should I proceed?" In the case under consideration, this need emerges only at a certain stage of problem-solving. However, the correlation is more often a reverse one: first a problem situation arises, then a task, or goal, is formulated on its basis. Thus, a verbally formulated task is a particular object even for a person's thinking. A more general case is a "situation".

In Soviet psychology, the theory of problem situations has been developed by Alexei Matyushkin. The psychological

structure of a problem situation includes: a) cognitive need prompting the person to engage in intellectual activity b) an unknown piece of knowledge or mode of action (i.e., the object of the need) that is attained; c) a person's intellectual potential which comprises his creative abilities and past experience, factors that, as it were, define the range within which cognitive needs may arise. If previously mastered knowledge is sufficient for dealing with the task, a problem situation does not arise. Neither does it arise when previously assimilated knowledge does not allow a person to understand the intellectual task presented to him.

Matyushkin proposed a three-dimensional model of the fundamental plans of problem situations basing himself on such parameters as the "degree of difficulty", the "stages of the establishment of the action" and the "structural components of the action". Let us consider his theory using two problem situations differing in their structure as an example. In the first case, to fulfil the task, one has to find new means of attaining a known goal in a problem situation. In the second, one has to reveal a new regularity and relationship, which are required to explain a certain phenomenon or to prove the truth of a certain statement.

Motives are not simply conditions under which thought activity unfolds but factors affecting its productivity. Experimental research has been conducted to compare how the same problems were solved in three different experimentally created situations: a) action on a "neutral" instruction ("please solve the problem that is presented to you"); b) solving the problems in a competitive situation; c) solving the problems in the situation of "examining intellectual ability" (the latter was used only as an experimental device). The experimenters discovered that the productivity of problem-solving rose consistently when it formed part of the activity regulated by highly significant motives. The rise in the productivity was manifested both in the number of answers (which increased from 1.4- to 2-fold) and the change in their qualitative aspect, their content (a maximum 6-fold increase in the number of original answers). In the case of problems with more than one solution, more solutions were found, and in the case of problems with one solution, more testees found it.

The problem being solved always provokes a certain attitude on the part of the subject. It is evaluated by him, acquires a personal meaning for him, all of which serves to reveal the specific of the motivation of thinking. The attitude may differ

in "modality" (positive or negative), object (what precisely gave rise to this attitude), form of expression (verbal and non-verbal indicators), the way in which this attitude is manifested (alteration of the problem, willingness to take part in more experiments). One of the research works in the field made use of a problem borrowed from Edward de Bono's book *New Think. The Use of Lateral Thinking in the Generation of New Ideas.* Here it is.

"Many years ago when a person who owed money could be thrown into jail, a merchant in London had the misfortune to owe a huge sum to a money-lender. The money-lender, who was old and ugly, fancied the merchant's beautiful teenage daughter. He proposed a bargain. He said he would cancel the merchant's debt if he could have the girl instead.

"Both the merchant and his daughter were horrified at the proposal. So the cunning money-lender suggested that they let Providence decide the matter. He told them he would put a black pebble and a white pebble into an empty money-bag and then the girl would have to pick out one of the pebbles. If she chose the black pebble she would become his wife and her father's debt would be cancelled. If she chose the white pebble she would stay with her father and the debt would still be cancelled. But if she refused to pick out a pebble her father would be thrown into jail and she would starve.

"Reluctantly the merchant agreed. They were standing on a pebble-strawn path in the merchant's garden as they talked and the money-lender stooped down to pick up the two pebbles. As he picked up the pebbles the girl, sharp-eyed with fright, noticed that he picked up two black pebbles and put them into the money-bag. He then asked the girl to pick out the pebble that was to decide her fate and that of her father."

(Here, the story was interrupted, and the testee had to continue it, i.e., the problem was to find a way out of the situation that had emerged.) In actual fact, the story continued (i.e., the problem was resolved) in the following manner:

"The girl in the pebble story put her hand into the money-bag and drew out a pebble. Without looking at it she fumbled and let it fall to the path where it was immediately lost among the others.

" 'Oh, how clumsy of me,' she said, 'but never mind—if you look into the bag you will be able to tell which pebble I took by the colour of the one that is left.'

"Since the remaining pebble is of course black, it must be assumed that she has taken the white pebble, since the money-

-lender dare not admit his dishonesty."

With a view to actualise a variety of attitudes in the testees (evaluation of the degree of interest, the chances for finding a solution, or the difficulty presented by the task), the following factors varied: a) the form in which the task was presented to the testee (a text, a chart, a picture); b) introduction into the situation of the experiment ("I shall now present you a problem to solve", "I am going to present you a problem which I think you will deal with easily", "I shall now present you a problem which you will try to solve; so far, none of the testees have been able to do it."); c) the way the question (requisite) was worded: "Find a way out of this situation", "What would you have done if you were in the girl's shoes?" "What would you advise the girl to do?", "What, in your opinion, should the girl's father have advised her to do?"

The attitude to the problem was noted both before and after tackling it. Refusal to accept the problem offered by the experimenter manifested itself in substituting another, ethical problem for it: "Is it all right for a young girl to marry an old man?" The degree of activeness reflected in the person's attitude to the problem which, as it were, characterises the degree of its acceptance and the degree of the person's involvement into solving it, was expressed through the number of the solutions that had been evolved and the vigour that went into the defence of these solutions. An active attitude to the situation of the experiment was reflected in the testee's going back to the experiment and involving others in it. An active attitude to the experimenter manifested itself in evaluating his evaluations, the search for some hidden meaning of the problem that the experimenter had not mentioned. It was reflected in the study of the experimenter himself.

When the task itself is evaluated as an interesting one, this favourably affects the work towards solving it, and vice versa. The same effect is produced by the realisation that the task is solvable, by a positive emotional attitude to the task, and the vigour of this attitude. The very attitude to the task is evolved under the impact of such factors as the form in which the task is offered to the testee, the character of instructions and questions. The results of the work (success or failure to solve the problem) produce a reverse effect on its evaluation and the attitude to it. The testees who had failed to solve the problem tended to evaluate it as insolvable, uninteresting and silly, even if before the experiment they had stated that it was solvable and interesting. Such changes in eval-

uations are often observed before a refusal to tackle a problem. The changed attitude to the problem acts as a motivation, a vindication of one's own failure. A change in attitudes may be connected not only with the task but also with the experimenter. A testee who under the conditions of the experiment has received just one problem often solves a number of problems, with the others being formulated by him and for himself. For instance, "to find out the purpose of the experiment", "to find out what is being analysed", "to justify one's result", "to help the experimenter".

In the process of problem-solving, cognitive motives not only interact with external ones but have their own logic of development. Discovering an incongruity between the methods of action and the conditions of the task, a gap between the conditions and the requisites of the task, a contradiction between the initial data and the unknown quantity, the relations between the preceding and subsequent goals as they are being steadily attained—all this acts as an internal source of motivation in problem-solving. Apart from external and internal motivation, also distinguished are situational and stable motives (dispositions, attitudes).

Of course, one must not think that the task should be correlated only to the subject's motivational sphere. On the contrary, it should be included into his cognitive sphere. The conditions and requisites of the task must be grasped by the subject.

The solution of a problem always means interaction between the subject and the object, in the course of which not only the task, i.e., the object of thinking, but the subject himself become transformed. We shall now proceed to analyse this interaction, i.e., the *activity* involved in resolving a task.

Chapter Three

THINKING, CONSCIOUSNESS, THE UNCONSCIOUS

§1. The Conscious and the Unconscious in Thinking

The first attempts to draw a general chart of the processes involved in solving intellectual tasks were undertaken by scientists who based themselves mainly on the observation of their own mental processes and descriptions of how other people's thinking proceeds. It is possible to select a task, present it to any testee, and ask him to solve it, and then, having either removed it or left it before him, ask him to describe how his thinking developed. Adults can, of course, come up with some sort of description. Drawing on accounts given by major figures in the intellectual field (scientists, inventors), interviews and biographical data, psychological literature has evolved a certain concept of the principal stages of the thought process. This concept is in fact an answer to the question: what are the "components" of thinking, what happens between the moment when a task that is subject to solution is accepted and when its solution is produced?

One of the widespread schemes of organisation of problem-solving presupposes singling out four stages: preparation, the ripening of the solution, inspiration, and verifying the solution. Let us stress once again that this chart is based on global descriptions or self-descriptions, and on self-analysis of thought activity made by major scientists and inventors.

Thus, the first source of knowledge about how the problem-solving process is organised is the data obtained as a result of accounts of one's thought processes, of self-observation and self-analysis. However, although this knowledge is of course valuable and necessary, it has its limitations. The four stages of the creative thought process mentioned above adequately represent a certain reality viewed macrodimensionally. It is important to remember that these are four qualitatively differing stages, that the stage of maturing is not at all the same as

the stage of inspiration, and that of verification is not the same as that of preparation. Why should this be borne in mind? Because, in delving into experimental psychological research, we sometimes deliberately concentrate on individual, specific mechanisms of problem-solving and lose sight of the overall macrostructure. A combination of macro- and micro-analysis is a necessary condition of psychological research into the processes of problem-solving.

A more informative method is thinking aloud in tackling a task. This method has been introduced and found wide currency in the writings of Gestalt psychologists. For example, let us consider an analysis of the solution of a problem used by Karl Duncker. The testees were told: "Your task is to find a way to use powerful ray treatment which destroys healthy tissues to cure a malignant stomach tumour." An analysis of the records of the testees' deliberations makes it possible to single out the stages and the overall scheme of the search for the final solution. First, the testees tried to eliminate contacts between the rays and the healthy tissues, to send the rays through a tissue-free passage (via the gullet), or to bring the tumour towards the surface of the body (by pressure). Then they tried to reduce the healthy tissues' sensitivity by gradually increasing the intensity of the radiation. Finally, they proposed to eliminate the harmful effect of the rays by means of a lense. Thus definite stages of the search were defined, which ended in formulating the variants of the task's solution. A specially noted point was that of defining the principle (the functional solution). For instance, the "gullet" variant is the application of the principle of "free passage to the stomach" to the specific conditions of the human body. Also described was an important phenomenon of transforming or restructuring (reformulating) the original problem: from the search for a way of treating the tumour without damaging the healthy tissues to the demand to reduce the intensity of the radiation en route. It was shown that each decision arises out of consideration of the data from the required point of view, with these two components varying greatly with respect to their participation in the emergence of a definite stage of the solution. A characteristic was given of the analysis of the situation, of the goal, the lessons learned from the errors, and the realisation of the conflict's foundations. However, even Karl Duncker noted that the records were not exhaustive. It is nevertheless true that even now, the essence of the process of problem-solving is sometimes reduced to verbally re-formulating the original

task, i.e., to the processes that unfold at the conscious level.

Recent research has proved quite convincingly that thought activity is realised both at the conscious and the unconscious level and is marked by complex transitions and interactions of these levels. Research into the unconscious in thinking is in fact a study of intuition.

An interesting approach to the interrelationships of the conscious and the unconscious in thinking has been demonstrated in the works by Ya. Ponomarev. The author proceeds from the fact that any object-related action is not homogeneous: any successful (purposeful) action produces a result which corresponds to the pre-set goal (a direct product of action), and a result that had not been envisaged by the realised goal and which is a by-product of the given action. The question of the conscious and the unconscious has assumed a more concrete form in the problem of the interrelationships of the direct (realised) and the secondary (not realised) products of action. The by-product of an action is also reflected by the subject, and this reflection may take part in the subsequent regulation of actions, but not in a verbalised, conscious form. The by-product emerges under the impact of those specific properties of things and phenomena which are included in an action but are not essential from the viewpoint of its goal.

One of the tasks used by Ya. Ponomarev in his experiments is represented in Figure 4. The testee was requested to draw three uninterrupted pencil lines through four points and have the pencil return to the initial point. In a specially selected leading problem (the game of "Khalma"), the testee "charts a route with his hand which coincides with the design that has to de produced to solve the 'four points' problem; in other words, the route traced by his hand totally coincides with the graphic solution of this problem".

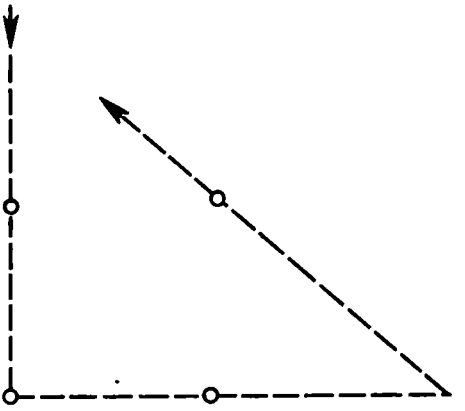


Fig. 4. The "four points" task used in experiments investigating creative thinking

However, this attempt at prompting remained a by-product of action and did not always help to solve the main problem. The author has shown that converting a by-product of action into a direct product proves possible when the "prompting" is preceded by the main task, and not always even then. Factors

have been revealed that facilitate such a conversion: simplicity of the motivating problem; simplicity of the revealing problem; insignificant automation of the mode of action through which the prompting is done; generalisation of the method into which the by-product is converted; insignificant objectification of the subject's need in direct products of action.

In the course of research into the relationship between the direct and the by-products of action concrete form was given to the perception of thinking as "orientating", which is associated with singling out the strictly psychological aspect of research. A line is drawn between orientating based on "reflecting a direct product of action" and orientating based on "reflecting a by-product". In the first case, the testee is certain of success and is always able to give a correct account of his actions. The success of orientating does not depend either on the repetition of the "prompting" or on the time which has elapsed between the "prompting" and the task that reveals its effect. In the second case, confidence of success is lacking; a sensual foundation is a must; the testees cannot explain their actions; what is more, such a requirement disrupts the normal progress of orientating; the efficiency of orientating becomes dependable on the number of times the "prompting" is repeated. Orientating is undermined when a long time passes between the "prompting" and the task revealing it. The conversion of the reflection of the by-product into that of the direct product is interpreted as *reorientating*. Consequently, thinking comes forth not only as "orientating", which has qualitatively differing forms, but as "reorientating".

The unconscious in thinking often assumes the form of attitudes which are clearly manifested in experiments. Testees (all of them pupils) were offered the following series of similar sums: "You have three vessels able to hold 21, 127 and 3 litres. How can you use them to measure out a hundred litres of water?" (The solution is to first fill the largest vessel and then pour out 27 litres—21 and twice 3 litres.)

The five or six arithmetic problems that followed could be solved in the same way. Then, without warning, the pupils were given sums that could be solved in another and simpler way. For example: "You have three vessels with a capacity of 23, 40 and 3 litres. How can you using them measure out 20 litres?" The testees solved the problem in the following way: first they filled the 40-litre vessel, then poured out 23 litres, and then added another 3. The pupils who had not solved the preceding series of problems found an easier way: pouring out 3 litres

from the 23-litre vessel. This experiment shows that the attitude formed at the unconscious level determines the selection of a possible way of solving a problem, each leading to a solution but differing in degree of complexity. The mechanism of an attitude evolves at the unconscious level and acts as a sort of by-product of a whole sequence of purposeful actions. A special warning "to take careful note" of the problem's conditions and not to produce incongruous solutions did not affect the outcome. For instance, when the pupils whose attitude had been formed, dealt with the problem: "You have 3-, 64-, and 29-litre vessels, how can you measure out three litres?". From 52 to 85 per cent of the testees said that one should fill the 64-litre vessel and then pour out 58 litres (twice 29 litres), and 3 litres. This made them "overlook" the simple solution.

Attitude is subjected to a detailed study, above all, in the Georgian school of Soviet psychology, but it has recently attracted more general interest within the framework of research into the problems of activity and personality. With reference to thought activity, attitude has been analysed by Nikolai Eliava. He uses Dmitry Uznadze's concept as a starting point describing attitude as the subject's inclination, orientation and readiness to perform an act that can satisfy his need, as predisposition for engaging in certain activity directed at satisfying a meaningful need. As distinct from a number of foreign theories, attitude as interpreted by Dmitry Uznadze is not a purely subjective factor but is determined by objective conditions and regulates the subject's psychic activity in conformity with these conditions.

Eliava believes that a distinction should be drawn between the fixed and the flexible, dynamic attitude. The specific feature of the emergence of attitude in a problem situation consists in the fact that the subjective factor of attitude is a gnostic need, and the objective factor—a situation which is not yet fully outlined, which contains a problem and, consequently, must still be resolved by the subject's mental activity. The specifics of human psyche are associated with the awareness of objective reality and of oneself as a subject who enters into a relationship with this reality, the so-called objectivation act. It is the latter that makes thinking possible: on its basis thinking acquires its object. At the same time, a new and higher form of attitude also comes into its own.

Conducting experiments involving classifying and understanding texts (short stories), the researcher has shown that a fixed attitude manifested itself, first and foremost, in the

fact that the subject would not accept the task set before him and did not notice the problem situation. The attitude-related effects were demonstrated in the following manner: the testees were offered two variants of a text in quick succession, with certain letters omitted in some of the words: "A c—w was —ying among the —ocks..." the attitude implying either "cow" or "crow". This determined which gaps were to be filled in by the testees. It has been established that attitude predetermines the range of versions adopted by the testees.

An interesting aspect of the relationship between attitude and image thinking was analysed by R. Natadze. Whereas in the classical experiments conducted by Dmitry Uznadze attitude was studied using the materials of perspective illusions (the testees were asked to compare the size of two balls which they held), R. Natadze suggested the testees *imagine* that they were holding two different-sized balls given to them for comparison. It was shown that an attitude corresponding to one which was imagined could evolve. Whether the conjured image would produce the corresponding attitude depends on how the subject felt about what was being imagined (the really existing or the expected, one to be realised, knowledge about the non-reality, actual perception of the situation which is opposite to the imagined situation). When there is awareness of the non-reality of that which is imagined, a positive role is played by the subject's active approach towards that which is being imagined (and which is conjured either voluntarily or involuntarily). Evolving an attitude on the basis of an imagined situation forms the foundation of an actor's and child's role-playing.

Experimental research into the unconscious has been traditionally associated with hypnosis and suggestion. The following experiment may serve as an example. A person in a state of deep hypnosis is persuaded that he is an eight-year-old child. He is then asked to write to dictation on the blackboard, which he does in a handwriting that can be expected to belong to a child of that age. At first sight, this may seem simply a hoax, but experiments have proved that the man's past experience is really being actualised.

Experiments have been conducted that have demonstrated the role of the unconscious in thinking processes. The testee, Misha, a third-year math student at Moscow University, had been hypnotised and told: "When you hear three knocks, you will pick up the shoes standing under the couch and take them to the next room." Aroused from the hypnotic state, the student

could not remember anything about it. Hearing three knocks, he began to look around the room (a doctor's office), where the experiment was being conducted. He saw a pair of shoes standing under the couch and walked towards the shoes. One of the experimenters began to enhance the conflict potential of the experiment in the following way:

"Misha, what are you going to do?"

"I want to pick up these shoes."

"But don't you know you must never take something that does not belong to you?"

"..."

"Misha, the nurse is in a hurry to go home. But she can't leave barefoot!"

In the situation of conflict between the suggested action and the ethical norm (one must never take other people's things), Misha found a very interesting solution: he picked up the shoes and took them to the next room leaving a note which said: "Your shoes are in the next room." In this way, the suggested action had been performed and the conflict slackened. After the experiment was over, we had a talk with Misha. When asked what made him take the shoes, he said: "I don't quite know, I just had an urge. I myself was surprised".

This experiment involved post-hypnotic suggestion. An instruction given to a person under hypnosis had prompted him towards action, although he was not aware of it when performing the action. It is a model of sorts of unconscious incentives, motives of a person's activity. Any complex action contains something that actually motivates him to act (motive) and the explanation supplied by the person himself for his action. These explanations may either coincide or fail to coincide with the real motive. Explanations are usually referred to as justification of motives. It should be noted that explanations are a result of thought activity.

Research has also been undertaken in which post-hypnotic thinking was used to solve intellectual tasks. Special experiments were staged to examine the possibility of post-hypnotic suggestion to the testee of an erroneous idea for solving the problem. A testee who knew how to play chess and had been hypnotised was shown a piece which he had to use in beginning to solve a chess problem after emerging from hypnosis (in actual fact, the problem could not be solved in that way). The researchers wished to see whether it was possible to experimentally build a barrier that would make a concrete task insolvable in principle, or whether the testee would be able to

reject the erroneous decision that had been suggested to him. The experiment showed that this sort of hypnotic suggestion slows down finding the solution (by up to 60 per cent) but does not prevent the problem from being solved. The testee begins by using the solution that had been suggested to him but, having analysed the situation and the possible consequences of the suggested action, rejects it, saying: "This won't lead me anywhere." Thus in the final analysis the results of the person's own research activity prove to exert a stronger regulating influence than the suggested evaluations of actions. However, the *relative difficulty of solving the problem and the direction of the first stage of the search for solution might be changed due to the impact of post-hypnotic suggestion.*

Suggestive phenomena can be observed beyond a doctor's office, and we shall deal with them.

§2. Unverbalised Research Acts

A significance of principle in the understanding of the psychological nature of thinking described by such terms as "process", "search", and "orientating" is linked to the study of exteriorised components which include the eye movements of a person dealing with a problem presented visually. This significance lies in the fact that as distinct from experiments involving leading questions or revealing the effect of attitude, here we come up against a "microanalysis" as it were of unconscious forms of the subject's orientating-research activity. This approach is discussed in a number of works that deal in particular with the functions of eye movements observed in the course of a person's mental activity.

The testees were chess-players, and their eye movements were recorded with a film camera. The factual material received as a result of primary processing consisted of data about the registration of various situation elements, the length of the registrations and their sequence (the trajectory of eye movements). A detailed description of the trajectory of the eye movements over the chessboard and an analysis of visual search were then undertaken. Taken as a unit of this analysis was the film still, i.e., changes in the activity occurring each $^{1}/25$th of a second. All in all, about 53,000 stills were examined. The testee's research activity, manifested through the eyes' search movements from the initial moment to the final solution of the problem, was measured against the following parameters: duration of individual registrations (individual and average time

of registration), the trajectories of the eye movements (the character and type of movements from one element to another); establishment of interaction between the elements forming definite systems; the frequency of the analysis of the elements making up these systems, and transformation of these systems by the inclusion of some elements and the exclusion of others. Also considered were the generalised, summary indications of eye movements in each concrete situation, i.e., the frequency and duration of registrations of each element of the situation. The results that had been obtained were compared to the testees' verbal account of the choice of moves in every given position. The positions themselves were analysed with the aid of highly skilled chess-players.

The testees, players whose skills varied, were given the following instruction: "In this position, you must make the best possible move playing with white (or black) pieces. Name it." The very shifting of the piece in the experiment, i.e., the performing of a concrete action, was fulfilled by the experimenter but on instruction from the testee. In view of the specific direction of the research towards mechanisms of mental activity, the principal experiments were arranged in a way that cancelled the need for the testee's initial (mostly perceptual) acquaintance with the situation (position). This methodological task was accomplished by analysis of problem-solving activity with reference to the positions occurring in the games that the testees played during the experiment (fragments of the permanently proceeding struggle objectified in eye movements were filmed). The only new element in those positions was the last move of the adversary (which was intentionally not named out loud), while the position of the other pieces could be named by the testees without looking at the board. Thus the need for perceptual orientating was reduced to a minimum.

To reveal the functions of eye movements, the trajectory of the eye movements was carefully correlated against the situation in which these movements took place. It turned out that the most typical case was for the testee to "rehearse" certain moves in the given situation. In the simplest case it took place as follows: first the square in which the piece stood in its initial position, then the free square to which the piece could be moved in conformity with the rules of the game were registered. Thus the eye movements objectify a certain action involving a situation element. This is not practical action (it is not this move that will later be named as the solution), but at the same time, it is not an internal (mental) action as such. It is

a *research action which has an externally expressed form.* The term action is used in its broad sense here, as a unit of orientating-research activity. If we make a distinction between operation and action in the narrow sense of the term, then we can say that "rehearsals" of the moves may be either operations or actions. When "mental actions" are referred to no distinction is made between action and operation.

Research actions which manifest themselves as a move with a piece may sometimes have another form: the eye moves from the square to which the piece could be moved to the piece itself ("reversed rehearsal"). While research actions of the former type pertain, first and foremost, to the pieces, the actions in the latter category pertain to the free squares on the board. Research actions are executed not only with reference to the existing situation but also to the situation that may evolve in the future (i.e., after a certain transformation of the existing situation). The testee's rehearsal of the moves possible in a certain situation reveals the functional relationships among the situation elements (defence, attack). Whereas attack is essentially an action which directly prepares the following action of capture, defence is, so to speak, a potential action: if the adversary takes a piece (which is defended), the piece that is doing the taking can, in its turn, be taken. It is precisely these research actions ("rehearsals" of the pieces' specific potentialities) and establishment of the functional relationships between elements that occupy the principal place in the testee's activity.

A matter of principle, which should be dealt with here, is the nature of man's research actions described earlier. These research actions are directed not at reflecting the form, colour or position of the elements but at establishing relationships between the elements of the situation (the pieces and the empty squares on the board). As these relationships are being established, features of the elements inaccessible to direct sensual reflection become revealed (a function cannot be "perceived", just as "hardness" cannot be perceived). Consequently, what we are dealing with here are *external essentially non-perceptual research actions* (the actions described above cannot be characterised on the basis of the functions that are usually singled out in the context of research into perception —the metric, the assimilating, and the control functions of eye movements). Consequently, what is registered are actions which make possible a mediated reflection of the properties of elements in a given situation. This is reason enough to consider such actions as components of thought activity proper (the ori-

entating process) of the testee seeking a solution of a definite task.

The research actions described here, which for brevity's sake have been termed "rehearsal movements", are the predominant but not the only form of eye movements demonstrated by the testees. Occasionally, during a certain time, their eyes moved from piece to piece. These movements were not guided by the pieces' functional property or their position but were selective. The zone of such activity embraced both the testee's own and his opponent's pieces. All pieces had already been objects of previous research activity and related to the move which the testee was going to make. As a rule, such movements are associated with the operational enlargement of the units of activity. They were termed "unifying".

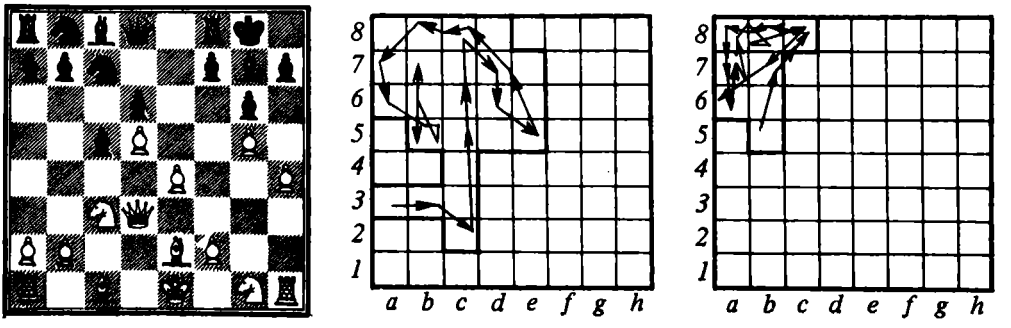
Apart from these forms of eye movements, it was possible to observe a consecutive shift of the eyes from one element to another, with each of these elements having already assumed a definite role in this activity as a result of its earlier transformation (these elements were either similar in their functional potentialities or, vice versa, competed with each other). These movements were always associated with lengthy registrations, occurred exclusively at the final stages of problem-solving, and characterised the process of selection of the final solution from among the previously chosen possibilities. Still other forms of eye movements were general shifting ones, and the movements induced by various chance factors.

From the methodological viewpoint, a significance of principle belongs to the question of comparative information value of the eye movements and the testee's verbal report, which is often used in research into the processes involved in problem-solving. Special analysis has shown that a verbal report reflects only those moves and variants with reference to which *substantial pieces of work* have been registered in visual search. At the same time, visual search objectifies the testee's analysis of certain moves which are not at all mentioned in the verbal report. As a rule, these are "bad" moves which engender a dramatic deterioration of the situation, and variants involving a small number of moves. Apparently, eye movements are more informative than a verbal report (and, as we shall see, thinking aloud); their analysis makes it possible to understand some of the mechanisms of actual thought activity.

All forms of research activity: rehearsal of certain potentialities of the pieces with a varying degree of thoroughness, revealing interactions among the elements of the existing and

the possible future situation, uniting elements into sets or systems, comparing different elements on the basis of revealed characteristics—are executed at different stages of activity. This research behaviour depends on the task facing the testee, reflects the nature of this task, and performs the function of finding a solution to it. An analysis of this research behaviour is in fact an analysis of thought activity initiated by the need to solve the task at the unconscious level.

An analysis of the data that was received has shown that the principal form of research activity, which manifests itself through eye movements (Figure 5)—the establishment of functional interactions between the elements—has a complex and diversified structure. The interactions may serve either as a means of the initial analysis of the situation, or as a means of registering the results of research work. The former occur at the initial stages of the thought process and are inconsistent, unplanned, and repeat already rehearsed interactions. The characteristics of elements revealed as a result of such research actions direct the activity that follows along a definite route: the search for other properties and functional potentialities of an element, the search for functional properties of other elements which prevent the first one from realising its potentialities, etc. Revealing definite properties of a specific element, the testee proceeds to consider it as one having these properties. The second type of interactions is encountered, as a rule, in the final stages of the search and is characterised by regularity and consistence of the functionally subordinate operations. It is, in fact, the systematisation of earlier actions, being, as it were, control actions.



a b c

Fig. 5. A study of unverbalised forms of orientating-research activity: *a*—position in a chess game before black's 11th move, the opponent's last move Q dl d3; *b*—orientation zone and an excerpt from the record of eye movements between the 30th and 34th second of the search; *c*—orientation zone and excerpt from the record of eye movements between the 34th and 39th second of the search

Just as important is the following distinctions between research actions: direct rehearsals and rehearsals that have been prepared by mediating interactions. The first are performed spontaneously, without any preparatory work involving these elements. The second type, which is much more complicated, is characterised by the fact that a direct rehearsal, which realises certain functional interactions of the elements, acts as a subsequent stage of the search process. Even this cursory analysis allows us to make an important conclusion, i.e., that at the unconscious level of realising thought activity the psychological mechanisms are not uniform.

Experiments have shown that during the period preceding the discovery of the final solution (the choice of the move), an enormous amount of *research* work is performed with the help of the eye. A summary, generalised indicator of this work is the *overall orientation zone* in a given concrete situation. The orientation zone incorporates all elements of the problem's conditions registered by the eye in the course of searching for a decision. The number of these elements defines the volume of the zone. Individual elements are characterised by the number of registrations and the summary duration of the registrations, which give some idea of the *structure of the orientation zone.*

One of the main factors uncovered by the research is that the volume of the orientation zone is always smaller than the overall number of the situation elements and is variable, changing from one situation to another. Since some psychologists believe that only an action with a complete orientation basis is of full value, it should be stressed that the level of complexity typical of chess problems precludes "complete" orientation, making it in fact impracticable. An important part of the psychological study of thinking is an analysis of the factors which determine the volume of the orientation zone and the mechanisms regulating the search activity preceding the discovery of the solution.

The overall structure of the orientation zone makes it possible to form an idea of the relationship between the objective characteristics of the conditions of the task and the shape that these conditions assume when viewed by the subject, i.e., the *mental (psychic) reflection of conditions at the unconscious level.* For instance, the degree of the element's functional load can be compared with the frequency of its registration. An analysis of records of eye movements shows that certain elements, which perform a number of functions simultaneously, are registered up to 32 times. In this case, one may speak of a certain correspondence between the intensity of research

activity and an element's objective properties. The same sort of correspondence is observed when the orientation zone does not embrace elements which have no active part in the pieces' interaction. And vice versa, in other situations one may observe that objectively "strong" transformers of the situation (moves) do not enter the orientation zone. Thus, basing oneself on objective indicators, one can find out what place in the testee's activity belongs to the situation element, correlate it with its objective value in a certain situation, and from this judge how fully and adequately the task's characteristics have been inferred from its conditions and, checking one's reasoning against the task's requisites, one can also make an assessment of the factual foundation, the factual "orientation basis", which precedes the next practical action.

As noted, the volume of the orientation zone is a variable. The maximum number of elements registered in the experiments was 60 out of 64, while the minimum was 4. Thus, depending on the volume and structure of the orientation zone, the situation looks different to the testee. These figures themselves are an objective indicator of how exactly the situation presents itself to him.

A major trend in the study of unverbalised components of man's thought activity is the analysis of the changes in the volume and structure of the orientation zone (and, in the long run, an analysis of the unverbalised reflection of the task's conditions by the subject), and analysis of the factors which determine the variability of these factors. Research has shown that when tackling a game task in a specific situation, a special stage at which the opponent's potentialities were examined was always singled out. It was established that at the outset of search activity, the testee predominantly ponders the opponent's possible actions, while analysis of his own action was almost fully absent. As the search process unfolded, the correlation changed.

A study of the opponent's functional potentialities, which clearly precedes the effort to assess one's own potential, to a large extent determines those elements of the situation which the testee has to deal with later. There is reason to think that this is the stage at which hypotheses are formed (but not necessarily verbalised) concerning the opponent's probable actions. These hypotheses are not equally valuable as far as their significance is concerned. Some are viewed as more probable, and others as less probable. It has turned out that an objective indicator of the work to assess the hypotheses is the frequency

with which the situation changes foreseen by the testee are rehearsed visually (sometimes, the maximum number of rehearsals is produced by the opponent's action which is fraught with the greatest danger). These rehearsals are, in turn, connected with nearly all subsequent activity aimed at solving the problem and with those elements which are its objects.

Research has revealed that forming hypotheses about forthcoming changes in the situation is an important mechanism, whose functioning regulates the scope of the overall search process. When the next change in the situation is the one predicted by the hypothesis, the search is substantially narrowed down, while when the change has not been predicted (i.e., under subjectively new conditions) the search is substantially increased in scope. Consequently, analysis of the actual change in the situation against the one that has been expected acts as a concrete psychological mechanism regulating the volume of the orientation zone, and, consequently, the content of the mental (psychic) reflection at the unconscious level (how probable the testee considers a situation change can be inferred from his verbal account). A special analysis of cases when research activity has been curtailed and, as a result, the volume of the orientation zone was small, has shown that an important factor affecting the reduction of volume was transferring the results of research activity from one situation to another, the basis of this transfer being unverbalised generalisations. In fact, one must not simply distinguish between research and executive (practical) activity but be aware of a complicated hierarchy, mutual positions and the continuity of research actions of different types.

Transferring the results of research activity (i.e., non-verbal generalisations) from one situation to another may lead to the testee's failure, when choosing a concrete action in a specific situation, to establish the interactions pertaining to the chosen move between the situation elements, and these elements prove to be outside the orientation zone. A consequence of this mechanism's functioning is the reduction of the search's duration. Instead of rehearsing some of the interactions between situation elements, only some of these elements are registered (analysis of earlier research activity reveals the rehearsal of these interactions in full form). Some of the variants of the moves are eliminated. There are facts of operating, in some situations, with a ready-made set of elements (the formation of such a system can be traced in earlier action). All this leads

to reduction of search activity in a specific situation, which in the long run restricts the orientation zone.

Objective study of orientating-research activity in the course of problem-solving has shown that the "scopes" of the segmentation of practical actions proper in situations and of research actions do not coincide. The rules impose quite rigid restrictions upon man's practical actions. For example, in each concrete game situation, a person may accomplish only one practical action (move), while the next one may and should be made after the opponent has changed the situation (made a move), thus the obligatory character of taking turns with one's opponent throughout the game. The situation (position) is viewed as "new" after each single practical action by one of the sides, since it allows one of the players to make a new move. However, in research activity these restrictions are non-existent. In each specific situation, a person may perform not one but any number of research actions, perform actions which the rules of the game make impracticable in a given situation and which, at best, could actually be executed only *after* certain transformations of the situation. The testee may consider a number of his own moves in succession ignoring the opponent's possible moves in return or, vice versa, consider consecutive moves involving the opponent's pieces disregarding his own moves. A situation which makes it possible to take a new practical action may be completely known to the testee, especially if the latest actual transformation of the situation has coincided with his expectations (hypotheses). The extensive transfer of the results of research activity from one situation to another may produce a state of affairs when the formal segmentation into situations fails to coincide with the way these situations manifest themselves to the testee. The main fact is that groups of situations begin to be viewed by the testee as a single whole, and the actually unfolding research activity becomes in fact related to the entire group of situations.

The following conclusions can be made from the above:

1) the "orientating basis" of a concrete action may be built in advance, some of the practical actions prove "pre-orientated";

2) thought activity at the unconscious level is not constructed after the "game tree" pattern with the necessary alternation of moves (one's own move—the opponent's move—one's own move—the opponent's move);

3) an unconscious psychic reflection of entire groups of situations is formed;

4) it is necessary to differentiate the concept of "new situa-

tion": a) from the angle of physical (practical) action and b) of thought action proper.

§ 3. Unverbalised Senses in Thought Activity

An analysis of the sequence of visual registrations of the various situation elements has made it possible to reveal some of the essential characteristics of the problem-solving process. One of the main facts, which became clear as a result of experimental research, was that a tactic of sorts had been evolved under which the same situation elements were repeatedly examined by including one and the same element into a variety of interaction systems. Experiments have demonstrated that the same element of the task's conditions may, within a period of 1 minute 46 seconds, become subject to re-examination about 20 times, each individual examination serving to bring out one of its functions ("attack", "defence", "support", etc.). The same situation element demonstrates a variety of characteristics as a result of search actions. These characteristics became revealed not through the testee's constant work with this element alone but through work with this and other elements in succession. Even the characteristics that were revealed were repeated more than once, now receding into the background, as it were, now moving to the forefront and prevailing. Finally, the testee never disclosed all objectively existing characteristics of the element.

We see, then, that the following fact has been established: as a result of various unverbal research actions, the same situation element is perceived by the testee in different ways depending on the stage of the period preceding the choice of a practical action. This specific form of psychic/mental reflection of the object, which stems from the different research actions undertaken by the subject and which changes as one and the same task is being tackled, is not a perceptual image (we shall agree that the latter is limited to reflecting such properties as colour, shape, position within the system of spatial coordinates, proximity to other elements). It is not a concept (which registers the stable properties of the element independent of the situation: the modes of movement and influence, absolute value). It is not the element's personalised meaning for the subject (it can be regarded as a constant when for 1 or 2 minutes the subject is working on a task that is of no special significance for him). It is not the objective situational meaning of the element, since out of the entire range of objective meaningful

features, search actions single out only a few (changing) characteristics of the object. The specific form of psychic reflection described here is called *unverbalised operational sense*. This term designates individual mental reflection, which does not fully coincide with the objective meaning of the element, with its meaning registered in social experience, and which differs from the personalised meaning of the object determined by the motivation of activity, as well as from the perceptual image. Unverbalised operational sense is a new unit of analysis of the unconscious, which differs from both "attitudes" and the "by-products" of action.

A major characteristic of the problem-solving process is the development of the senses of definite situation elements. This development does not proceed smoothly and evenly and may include from one to thirty re-examinations. The sense is the result of the execution of a certain group of search operations, with the operations themselves being an objective indicator of the sense and its development. As was noted, sense develops by including one and the same element into a variety of interaction systems. Research activity creates certain stable systems of interacting elements which in their turn change through the reduction of some elements and the incorporation of others. The formation of systems is not passive amalgamation of a number of elements but a result of vigorous actions involving these elements, actions which reveal the elements' functional properties. An analysis of data yielded by experiments has revealed that each new element becomes utilised in activity mainly by its incorporation into previously established systems, which direct the search towards elements possessing definite properties. These elements, in turn, produce transformations in previously created systems. As the problem is being solved, this research process leads to a gradually deepening and changing reflection of the situation, i.e., of the unverbalised operational sense of the situation for a person. Thus, alongside the unverbalised operational sense of the individual elements, one may speak of the operational sense of the situation at large. Naturally, complicated relations may emerge between the two. As a rule, in dealing with a problem, the testee has to do with not one but a number of element systems. Occasionally, the transition from one system to another is clearly visible. This also describes the specifics of the operational senses of the situation.

Analysis of the dynamics of the search process in situations when it is clearly enough expressed, has shown that the search

preceding the solution of a problem has a number of stages. The objective indicator of this differentiation is the changing number of elements with which the testee is actually working at the different stages of problem-solving. To designate this fact, we use the concept of particular or intermediate orientation zone (to distinguish it from the overall orientation zone, which characterises the investigation of the situation throughout the entire period of problem-solving), this meaning the number of situation elements examined by the testee at a certain intermediate stage of the problem-solving process (for instance, the 2 minutes in which a task has been solved may be divided into 5-second intervals, which will make up 24 intermediate zones). It has been shown that the volume of this orientation zone also changes several times in the course of solving a problem (for example, from 23 to 8 elements).

A dramatic reduction in the number of elements which are objects of thought activity is accompanied by qualitative changes in the nature of the established interactions: they become more definite, purposeful and selective. The activity displays a certain dominant interaction of elements. An analysis of the search makes it clear that the testee constantly goes back to rehearsing this dominant interaction, which becomes the centre of the cyclical element systems that are formed.

Analysis of dominant interactions revealed that they in fact implement certain real potentialities actually inherent in certain situation elements, visually accomplish a certain transformation of the situation which then may be accepted as a real practical action (but not necessarily—it may be rejected in the course of subsequent research activity). What we have here is, as it were, a task "pre-solution" which emerges at the unverbalised level. It can be termed unverbalised operational sense of the action. The "pre-solution" may either coincide with or differ from the final solution. The main thing is that we have found an objective criterion by which to establish the fact that the testee has discovered the sense of a possible solution, and has for the first time established the interaction between elements. This is represented as rehearsing an action possible in a given situation that would narrow down the ensuing search and make it purposeful and selective. The emergence of the sense affects subsequent research actions, which now consist of an examination of the interactions between elements associated with the sense that has emerged. This makes it possible to either accept it as final or reject it. Thus certain restrictions are imposed on the interactions under examination, and this

leads to a more purposeful and selective progress of the search.

Consequently, the search activity preceding the final solution of the problem has at least two qualitatively differing phases objectified through eye movements: 1) processes that produce the sense of the problem's possible solution and, in this way, the sense of future research actions; 2) evaluation of the sense that has emerged, its adequate correlation with the situation (the search for means of implementing it). In fact, in the course of solving a problem, one can see the phases repeatedly succeed each other and overlap.

An importance of principle is involved in the analysis of the research activity preceding the testee's formation of a "pre-solution" of the task (the unverbalised operational sense of the solution). It is this link which has usually escaped the notice of researchers who used exclusively the data provided by the verbal account or by thinking out loud, which has bred faulty ideas of thinking being, essentially, a henceforth undecipherable act of perceiving. In fact, as has now become clear, these ideas have been produced by the limitations of the methods applied in the analysis of thinking.

This stage of research activity ends in the first visual rehearsal of a concrete action, the emergence of the sense of the solution, i.e., the establishment of the interaction between two elements—a certain piece and the square to which the testee proposes to move it. Analysis of the structure of the activity which preceded the first rehearsal of this interaction was conducted along the following lines: a) the sequence in which each of the elements of the established interaction was included into the research activity; b) the sequence and modification of the interactions of each of these elements with the others. The elements of the interaction that is being established are usually included into the research activity according to the following pattern: the element (square of the chessboard to which the piece is going to be moved) is registered visually. Then the element (piece) which is going to be moved to that square is registered (each of the elements is initially analysed within its system of interactions with other elements); an interaction is established between the main elements, but in reverse order: from the element to which the piece could be moved, to the piece itself; finally, a direct visual rehearsal of the move is executed. This description is in itself indication enough of the complexity of the process, which leads to the emergence of the sense of the solution.

The interactions between situation elements, which can be

singled out in the visual search, are of a dual nature: a) rehearsal of functional relations between the elements of a given situation (in chess, defence, attack, etc.), rehearsal of possible situation changes (moves from the initial position); b) rehearsal of functional relations and situation changes which cannot be directly effected in a given situation (under the rules of the game) but which can be carried out after certain intermediate changes in the situation. While practical activity, which is restricted by the rigid rules of the game, allows only type (a) moves, research activity, as analysis has shown, often presents a diametrically opposite correlation: rehearsed first are interactions that may become possible at some future point, after certain changes in the situation [type (b)]; and only then does the transformation of the existing situation [type (a)] ensue, making it possible to practically establish the interactions of the first type. Thus, in establishing interactions, the testee initially operates with the properties of elements which could be acquired only after a certain transformation of the given situation. Such interactions are established without verifying the actual properties of the given situation elements, which could lead the testee to the originally discovered interaction. Following the establishment of the interaction which is practicable only after certain position changes, the testee engages in acts of search allowing him to find the element which can, on condition of its having certain properties, make the desired change in the situation possible. And only at the final stage can we observe that the testee directly rehearses a certain potentiality of the final element, the final link of a certain stage of activity, which signifies the emergence of one sense of the solution or other.

Functional interactions of the (b) type, i.e., certain transformations in the situation that can occur only at some future point, in other words, what *has* (in the testee's estimate) *to be done* in a given situation, the direction in which it should be transformed as a result of some as yet undefined actions, the desired object resulting from the situation's transformation—this means anticipating the presence in the object-related situation of elements possessing a definite property. Such functional interactions actualise the need for elements with definite properties which can meet a given need. To distinguish this specific need from man's other needs, it has been called the search urge. With the emergence of this urge, the search becomes more purposeful (directed at the satisfaction of the need that has emerged). It makes possible the prompt finding of elements that have certain properties (a criterion of selection

appears). As soon as the testee finds the specific element that meets the required properties, in the objectively recorded search one can discern its interaction with other elements which realises the required property, i.e., the rehearsal of the action which constitutes the emergence of the solution's sense. At this stage, the selective mechanism of the search is as follows: elements possessing certain properties are sought by the testee in conformity with a generalised model of the elements' properties required in the situation. As soon as the elements' discovered properties coincide with the model, this segment of search activity ends. The formation of this type of urge and the search for the element capable of meeting this urge have a different share in the search process. The former may take 45 seconds, while the latter—only 3 seconds.

The mechanism of the forming of the search urge and the subsequent search for the elements meeting it are major links in the overall process of problem-solving. Thus, while hitherto we have singled out two crucial moments in the problem-solving process, the formation of the "pre-solution" and the final solution, which are divided by the period of verifying or substantiating the sense, it now turns out that the very first period during which the "pre-solution" is prepared can itself be divided into two phases: the formation of the search urge and finding of the element that can meet this urge. The overall problem-solving process (at the unverbalised level) proves to have at least three phases: the formation of the search urge; finding the action capable of meeting this urge (the "pre-solution" or the sense of the solution); and the final solution. At each phase, the specific sense of research actions emerge and change. Just as the emergence of the specific sense signifies at the same time the emergence of a new line of action—checking the sense, in the same way the emergence of the search urge means that research activity develops in a new direction, is aimed at finding an object that can meet this urge. A common feature of all cases when an anticipation is formed is the clearly defined direction and selective character of search activity, which now becomes a search for means of attaining the result that was anticipated. At the same time, a very significant feature of activity has been discovered: that which has, at a certain stage, acted as a means of activity, in the future may begin directing further activity. For instance, rehearsing a move in a chess position (the sense of the solution) is a means of satisfying the search urge and at the same time a factor determining the course of further actions: to

check the soundness of the sense. Consequently, means are dynamically transformed into foundations of future actions, these transformations being a characteristic feature of activity.

We noted that the formation of the search urge is much more pronounced in activity than the search for objects meeting this urge. Analysis of the search activity preceding the emergence of such urges has shown that a common feature characterising the structure of the search taking place at a given stage is discovering the properties (by establishing the interactions) of those situation elements which are objectively linked to the general principles of conducting this type of activity (in chess, the rules of the game).

Problem-solving (choice of future practical action, i.e., the move) does not mean spontaneously testing the various potentialities of a certain piece and then deciding whether it has resulted in success or not (the trial-and-error method). On the contrary, the search proceeds, as it were, "from the result to the move"; at first, the testee deals with the situation element assuming a priori that it possesses certain properties, and only then rehearses a possible transformation of the situation (move) that can secure it these properties (the anticipation method). The mechanism of *anticipating* the elements' properties is not only a means of finding a certain move (sense) but also a means of promptly rejecting some other move, which also narrows down the overall search. The mechanism of forming search urges functions not only when moves are looked for proceeding from the initial situation, but also when they are sought in the variants, including those which are rejected in the process of their examination.

A study of the search mechanism in each specific situation makes it possible to better understand the nature of one of the basic phenomena that we have considered earlier—the changes in the scope of the search in various situations. The search begins by finding a factual change in the situation (the opponent's latest move). This is then assessed by establishing the interactions of the elements comprising it with other situation elements. On this basis, the anticipation of the results of future research actions is formed. The discovery of the situation changes may be either lengthy or prompt. It has turned out that the progress of this initial stage determines the scope of the research activity involved in solving the specific problem at large. If the change that has occurred in the situation is found quickly, the solution takes little time, a small number of situation elements is examined, and the very operations undertaken

to establish the interactions are reduced. If the situation change has been discovered after a prolonged search, the overall time of problem-solving is considerable, a considerable number of situation elements is examined, and the search activity has a wide scope.

Analysis (including comparison with the testee's verbal account concerning the opponent's expected move) has shown that the first stage of the search can usually serve as an objective indicator of whether or not the actual situation change and the expected one have coincided. If they have, the change is discovered immediately. If not, it is found only after some research activity. The character of the research actions with reference to the elements that have constituted the situation change also depends on the coincidence (or lack of it) of the situation changes with the senses (hypotheses) evolved by the testee: lack of coincidence prompts a re-examination of these and other elements, and their lengthy registrations. The main feature of search activity in cases when the actual and the forecast changes coincided, as distinct from the cases where such coincidence was absent, is that in the first instance, the testee can direct his activity at previously formed goals, whereas in the second, they only begin to evolve. Thus the mechanisms regulating search activity in the various situations function as a unity; checking whether the forecast and actual changes coincide becomes a condition (in case of coincidence) of the transfer of previously received products of research activity to the situations that follow. Thus the search becomes more selective and purposeful.

To single out intellectual work proper, which is objectified through eye movements, the principal group of experiments was conducted under conditions when the testee did not really have to make a perceptual analysis of the problem-solving situation. Naturally, this did not cancel the need for a study of the primary forms of eye movements aimed at getting the most general idea of the situation and recording its characteristics. This sort of task objectively arises when the testee is faced with the necessity of making a decision in an unfamiliar situation (in chess, a useful model is facing the testee with isolated situations).

In a series of experiments, the testee was asked to memorise an isolated position and then reproduce it without looking at the chessboard. Analysis has shown that the principal part of the eye movements was constituted by movements from one piece to another, most often those of the same colour. Average

time was calculated (throughout the overall period of solving the problem) of registering free and occupied squares, with the former amounting to 0.8 and the latter to 2.8 seconds. The search (objectified through eye movements) was executed in the following way: a certain zone was singled out in a given situation inside which the eye movements had been concentrated for a definite time, then the transition to a new zone took place. Such zones were usually singled out on the basis of the spatial principle: in chess, the seventh rank, a corner of the board, clusters of adjacent pieces surrounded by empty squares. Inside these zones, the eye movements consisted of a consecutive repeated survey of all pieces within the zone mostly from the point of view of their mutual spatial position.

All in all, the number of rehearsal moves when solving mnemonic tasks is much lower (20 per cent of the total). Prevailing among this share is the establishment of functional interactions between pieces of the same colour. The re-examination technique (to be found in solving intellectual tasks) is absent, as is the formation of elements systems on the basis of their functional interactions. When repeated research actions occur, they may pertain to insignificant situation elements and are stereotyped. The functional interactions of elements that are being established are formally possible moves which are unrelated to the specific features of the situation that either make these possibilities realisable or not. Prolonged registrations of elements between which an interaction arises are absent (in tasks necessitating the choice of a move these registrations serve as an objective indicator of the significance of the interaction for the testee). Rehearsal actions have no continuity, and the subsequent development of the search is not determined by the results of the interactions established between the elements. Consequently, in the structure of mnemonic tasks, the rehearsal movements themselves differ substantially from such movements in dealing with mental tasks. They are also directed, above all, at revealing the spatial relationships between the pieces. It is interesting that if a testee made an error when reproducing the situation (which happened when the time of studying it was restricted by the experimenter), the errors were mostly those of substituting the adjacent square for the one occupied by a given piece (a spatial shift of one square). In a word, the functional role of eye movements depends on the type of task tackled by the testee and in turn may serve as an objective indicator of the character of cognitive activity actually engaged in by the testee.

The search for solution was studied not only under natural conditions but also in a situation when the experiment presupposed maximum reduction of research activity, which was achieved by imposing a rigid time limit on the testees. The goal was to find out which of the mechanisms of developed research activity (described earlier) would be reduced and to what extent, and how the search would proceed in these specific conditions.

Experimental research showed that the average time of a single registration by all testees, in the case of a shortage of time, was lower (by an average of 0.02 sec.) than when no time limit was imposed. The number of prolonged registrations of individual situation elements decreased, and the overall number of eye movements per unit of time grew, i.e., the eye's motor activity was intensified. These facts alone denote the specific change in the share of the various mechanisms involved in the process of problem-solving: the establishment of relationships between the situation elements revealing the features of the situation proceeds more vigorously, while assessment of the importance of certain interactions and their place in the system of other interactions, and the processes of singling out the principal interaction are reduced.

When there is a shortage of time, what is reduced most is the process of selection of the final solution out of the "pre-solutions" (senses), their verification and specification. The indicator pointing to the number of elements under examination (the orientation zone) shows that when there is a time shortage, the value of this indicator is, in all cases, lower than when the time is not restricted, which signifies a reduced search process. It is interesting to note that none of the testees refused the offer of more time after having made a decision in the situation of a time shortage. This is an objective indication of lack of confidence in the decision's correctness.

Absent in the search activity were comparison movements and control rehearsals. The processes of forming anticipations were reduced to a lesser degree. The changes in this link of the search consisted in its reduced scope, absence of several simultaneous anticipations, and the creation of a hierarchy of anticipations. As a rule, only one anticipation was formed, which directed the subsequent research activity leading finally to the discovery of the final solution.

A comparison of the search process from the angle of the number and duration of registrations by the testee of his own and the opponent's pieces shows that when time is short, the

testee makes more and lengthier registrations of his own pieces than of his opponent's. Consequently, the link at which hypotheses about the opponent's actions are formed is reduced.

Development of visual search mechanisms involved in problem-solving. In order to reveal at least the more general tendencies in the development of problem-solving mechanisms when the overall level of skills is higher, a comparative analysis was carried out of the distinctions in the visual search for solution as determined by the testee's skill as chess player. The experiment involved a master, a candidate master, and a grade III player. The parameters compared were the ones analysed in detail earlier.

The average time of the situation elements' registration reveals that the longest registrations are made by the testees with the highest standard of skills (master). The difference in the average indicators can be explained, above all, by the emergence in the visual search of lengthy registrations which stood out from the basic mass (up to 7 seconds).

Special analysis of lengthy registrations has made it possible to establish that they were associated with either a) particularly significant situation elements (each next change in the situation, interaction of elements leading to the finding of a move for oneself or for the opponent, etc, etc.); b) a new position of one situation element or other; c) a specific stage in the activity at which, essentially, particular research results are summed up; or d) the overall decrease of locomotor activeness, which may be interpreted as the stage of interiorisation of activity, the stage of its transfer to the internal plane. While lengthy registrations of the first three types have been made by all testees, the last type of registrations has been demonstrated only by the master. Thus the first tendency that we can single out is the one towards reducing locomotor activeness, eye movements, in the process of tackling an intellectual task by transferring some of the links of this process exclusively to the internal plane.

Experiments have highlighted the differences in the very character of research actions: the proportion of rehearsals in the overall number of actions is the highest in the case of grade III player. This can be accounted for by a number of reasons. One is the overall reduction of locomotor activeness, which is, in its turn, attained by reduction of the search operations themselves. The very phenomenon of reduction of search operations is typical of all testees, but is expressed in various ways. The typical cases are: enhanced "meaningful load" of

one rehearsal action, which combines two different interactions; instead of rehearsing the situation elements' interactions, the registering of individual elements of these interactions as already possessing certain properties revealed on the basis of previously established interactions; such a substitution may evolve in the course of dealing with a specific problem; in the process of examining a specific situation, anticipation arises. For the master, the meaning of the situation elements is more frequently represented as "already formed" in the given situation (it has either been formed in the preceding situations within the boundaries of a given activity, or is the product of research into other situation elements).

Reduction of research activity is clearly visible with reference to control rehearsals of the moves. In the case of grade III chess player, they are the longest, and of the master, the shortest.

Reduction of the search operations themselves, most typical of the master, is usually most pronounced at some specific link of the overall problem-solving process: if the examining of the properties of the situation is curtailed, then control actions are more detailed, and vice versa. Thus, as the overall standard of activity is improved, "excess" search operations tend to become less numerous, and the various stages of the search repeat each other to a lesser degree. On the whole, reduction of search operations themselves is an indicator of sorts of the overall level of development of the mechanisms which allow the person to engage in complex game-playing.

At the stage of reduced search operations even the actions aimed at establishing interactions between situation elements are of a specific nature: the interactions being established belong more or less to the same category, include a very limited number of elements, are essentially repetitive and do not interact with other systems of elements. This type of change has been observed only at the "master" level and only when he dealt with problems which were subjectively estimated as easy.

All in all, two types of reduction of research operations can be distinguished. The first is a result of the work done in solving a specific problem (replacement of already executed rehearsals by registering elements, reduction of certain control rehearsals); it, as it were, characterises the stages of the solution of a specific problem and is observed with all testees. The second type characterises a stage in the development of a certain type of activity as a whole (fusion, in one rehearsal, of a number of functional interactions; emergence of the interacting elements' registrations without rehearsing the interactions

of these elements; termination, for several seconds, of eye movements conforming to the parameters that are being studied); this type is a feature of a master's game.

Re-examination of elements has been observed at the master level when the problem is subjectively sufficiently complicated. Comparison of the activity of the master and grade III player has revealed substantial distinctions in the very mode of element re-examination. The former accomplished the bulk of the work to re-examine certain elements (for example, two) before the emergence between them of an interaction either pointing to a possible solution or to a significant property of the situation contributing to finding it. On the contrary, in case of the grade III player the bulk of the work to re-examine the elements entering into the basic interactions was executed after these interactions were established. This fact points to more profound distinctions in the organisation of the search activity.

Comparison of the testees' work on the basis of the orientation zone volume revealed the following distinctions. The situation elements registered by grade III player most frequently and for the longest time (when added up) were the ones that formed part of an actual move, or his or the opponent's moves under analysis. As concerns the master, there were rare cases when elements of the move that was actually chosen as the solution, or the opponent's most probable reciprocal move did not fall into the orientation zone (the testee had not visually rehearsed these moves). Analysis revealed that this happened when the interaction between the elements that made up a certain move was estimated by the testees as "obvious" on the basis of activity in the preceding situations. The task of finding this move did not arise. In this case, research activity was directed at revealing the consequences of a certain interaction without actually rehearsing it. We have here a drastically different type of relationships between practical activity and the research activity that preceded it. The latter not only runs ahead of the former, but a certain shift occurs in research activity towards analysing the possible consequences of the planned action without first visually executing the action itself in the given situation.

The average volume of the orientation zone becomes smaller as the standard of the testees' skills becomes higher. The correlation between the orientation zone volume when choosing a move in positions occurring in a game, and one in isolated positions changes from a more extensive orientation zone in isolated positions to the smoothing out of this distinction at the

master level. This fact can be interpreted as follows: for a skilled player, an isolated position is associated, in an increasing degree, with his systematised past experience, with certain typical theoretical positions stored in his memory, and for this reason, in a certain sense, such a position ceases to be isolated.

We have noted that the dynamic changes in the orientation zone in various situations are regulated by comparing the actual and the anticipated changes, and are also determined by transferring the results of the research activity from one situation to another. It has transpired that efficient functioning of these mechanisms also secures a greater reduction of search activity in the case of a testee with a higher standard of skills. Coincidence of the actual and the anticipated changes are most typical of the master level; consequently, what we have here is a more perfect anticipatory mechanism. This, in its turn, makes possible the wider use of the results of research activity carried out in earlier situations; specifically, to act proceeding from previously evolved criteria.

The very process of forecasting possible situation changes may proceed in a variety of ways. As we noted in search activity, this process is objectified at the stage when the opponent's pieces are mostly studied. In view of this, the share of the work to examine the opponent's pieces may, on the average, be regarded as an indicator of the degree to which the operation of forecasting the possible situation changes is pronounced. A comparison of the testees' activity made on the basis of this indicator showed that the processes involved in examining the opponent's pieces are most pronounced at the master level (57 per cent), and least pronounced at the grade III level (40 per cent), with the testee concentrating predominantly on his own pieces.

A comparison was drawn between the degree to which the various problem-solving mechanisms are pronounced in the activities of the testees with varying standards of skills. The mechanism of forming the search urge should be especially observed since it determines to a large extent the future execution of the search. While organising activity proceeding from the emergence of the search urge in it is typical of the master and candidate master level, a grade III player seldom uses this mechanism in his activity. A testee with the latter level of skills tends to act on the basis of the existing and most obvious properties of the situation elements. His activity is reduced to revealing just such properties and to testing the elements' immediate potentialities. Research actions aimed at revealing the properties of ele-

ments that could be assumed by them only after certain transformations of the initial situation are rare. And it is precisely these actions that create what we call the search urge. The hypotheses concerning the practical action required in a given situation that the testee engages in, are accepted or rejected on the basis of the more general principles of attaining the chess game's final result and are not interpreted by the specifics of a concrete situation. It is therefore clear that one of the basic distinctions between testees with differing skill levels is the degree to which the processes of forming concrete criteria of choice, criteria of evaluating hypotheses during problem-solving, are present in their activities.

The distinctions in the work preceding the emergence of anticipations naturally produce distinctions in research activity after anticipations have surfaced. At the level when the first is not yet sufficiently pronounced, the second unfolds. The higher the standard of the testee's skills, the greater the proportion of forming anticipations as compared to the processes involved in the search for means of attaining the anticipated results.

The distinctions between the testees' activities in solving the same problem are as follows: the grade III player spent much more time looking for not even the best solution, he had a much larger orientation zone, he examined his own pieces much more intensively than those of his opponent, and the average time of his registrations was somewhat shorter.

§ 4. Types of Operational Sense

Tactile activeness during problem-solving as an indicator of unconscious work. The considerable methodological difficulties presented by experimental psychological research into man's thought activity, which in its developed forms is internal, greatly reduced and not wholly accountable to consciousness, import extreme significance to the analysis of specific cases when thought activity has maximum scope and lends itself to objective recording. Among such cases are, undoubtedly, games of chess played by blind people. In playing the game, choosing a move in a game situation, blind chess players display an extensive form of tactile activeness which expresses itself through establishing certain interactions between situation elements, and singling out certain points in the position (the opinion that sightless people play only "blindly" is not correct). It is this kind of tactile activeness that has been selected as the

object of experimental study aimed at revealing essential mechanisms of thought activity.

The cyclographic method has been used to objectively record the testees' tactile activity. They were allowed to use only two fingers (the thumb and the index finger) of the right hand. The leading role in research activity belonged to the index finger, therefore the ring with the bulb was put on that finger (the trajectory of the finger's movements was recorded on photographic film). The thumb's function was purely auxiliary. The limited number of fingers taking part in the work made sure that only one square on the chessboard was being scanned at any given moment, since distinguishing the three-dimensional shapes of the pieces required the use of two fingers. Besides, the testees were specially instructed before the experiment to touch only one square at a time. The unit of analysis was a cyclogram-sequence. All in all, 34,000 cyclograms were analysed.

Analysis has shown that the testees' tactile activity was selective: out of the overall number of squares on the chess board, only a certain part was touched. A record of tactile activity makes it possible to trace the dynamics of the selectivity of the testee's search and its dependence on various factors. The testee's tactile activeness reflected that which formed the object of his research activity: moves, interactions, variants. A comparison of the trajectory of the finger movements with the position on the board makes it possible, under a variety of conditions, to discover which possibilities are really considered by the testee, which makes the method employed in the experiment an adequate instrument for a strictly objective study of man's research activity in a game situation preceding a practical transformation of this situation.

Tactile activeness of blind chess players is a specific form of orientating research activity. Here, once again, as during analysis of eye movements, the need arises to differentiate between the perceptual and strictly intellectual components of this activity. The sense of touch has usually been examined as perception in its most extensive form. In the context of perceptual tasks, locomotor activeness is aimed at making "copies" of the objects' spatial properties, e.g., their shape. It also performs the metric function. In the experiments described the locomotor activeness of blind chess players was least of all directed at examining the objects' spatial properties: shape, distance and position, although these properties, too, may be the object of research activity. The activeness of the chess players

was directed, above all, at studying the features of the position, primarily the functional interactions of the situation elements ("threat", "pressure at the weak point", etc.), at examining the potentialities of one's own and the opponent's pieces (the testee touched the squares which were at the time empty but to which pieces could be moved later, as a result of certain consecutive transformations of the situation (moves) and checked the probable interactions between elements). In other words, the testee sought bearings not only in the present but in the future situations, this research process having an external, locomotor form. Locomotor activity was directly involved in the process of assessing the situation and preparing the next practical action. The establishment of functional interactions between the situation elements preceding practical action and revealing the properties of these elements is not a perceptual but an intellectual form of the testee's research activity (this refers, first and foremost, to the game of grade I and grade II players).

Analysis of research activity using the material of several full games played by the testees (the advantages of the cyclographic method over the recording of eye movements is that it gives a chance to record an uninterrupted process lasting for hours instead of several minutes), has shown that the testee never touched all the squares on the board but acted within the limits of a certain orientation zone to which the locomotor activeness was confined. An example of recording tactile activeness can be found in Figure 6. Inside this zone, tactile activeness is also not uniform: some squares were touched several times, others, fairly frequently, and, finally, there was a number of squares that were touched particularly often. Repeated registrations of the same element occurred when it was being consistently involved in the system of interactions with various elements. Here we are again faced with the element re-examination tactics, which is proof of its universality.

The volume of the orientation zone is a dynamic formation: depending on the situation, the testee touched a varying number of elements of the overall situation, and the distribution of registration frequencies also varied. Analysis was made of the factors which determined the reduction or extension of research activity in the process of the game. Among these factors is, above all, the stage reached by the game. Locomotor activity has the least scope at the outset of the game, expanding towards the middle and reaching its maximum dimensions towards the end. The second factor is the thoroughness of the situation analysis (awareness of the variants possible in a given position):

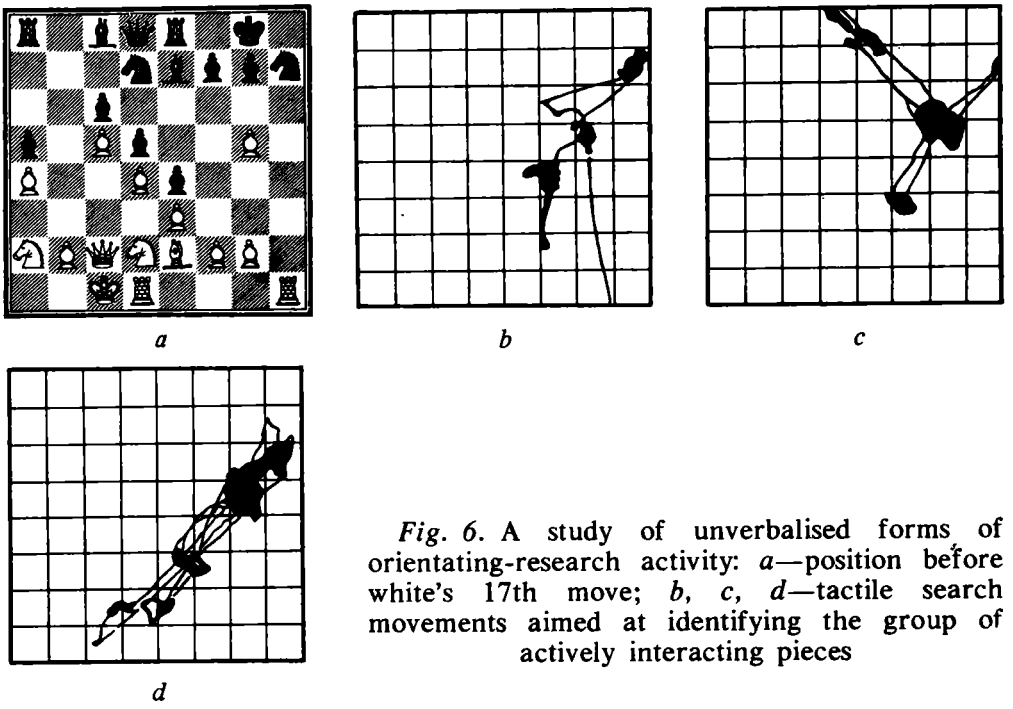


Fig. 6. A study of unverbalised forms of orientating-research activity: *a*—position before white's 17th move; *b*, *c*, *d*—tactile search movements aimed at identifying the group of actively interacting pieces

the more thorough the analysis, the more clearly locomotor activeness manifests itself. The third factor is the suddenness of the situation change (the opponent's latest move): in cases when the opponent makes a totally unexpected move, research activity is the most extended. The fourth factor is the objective complexity of the situation (this characteristic is relative, based as it is on the grading of game positions — borrowed from games — by more skilled players: an increase in the complexity of the position leads to heightened locomotor activeness). The fifth factor is the type of the game (when defending one's pieces in a closed position, locomotor activeness is less manifest than in attack). The sixth factor is the correlation of forces (the level of skills): the same player exhibits greater locomotor activeness in a game with a strong partner than in a game with a weak one. The seventh factor is how well the solution of a concrete task has been prepared in the course of examining earlier situations. An analysis of the entire game allows one to conclude that the vigour of tactile activity during the consecutive selection of separate moves varies: after very extended research activity, it becomes dramatically reduced when choosing the next moves, then drastically unfolds once more, and again reduced, thus forming cycles of sorts. Such fluctuations in the volume of the orientation zone occur because the results of research actions in one situation are then used in a number of subsequent situations, which testifies to a systems organisation

of the decision-making processes. The eighth factor: according to anamnestic data, highly skilled players display heightened tactile activeness at moments of emotional stress and excitement during important tournaments. Thus, acting as concrete psychological mechanisms regulating the volume of the orientation zone are such factors as the stage and type of game, the measure of impact on the opponent's position, the depth of forecasting and the complexity of the position, the degree to which the anticipated and the actual situation changes coincide, and how well the generated decision has been prepared while examining earlier situations. Consideration of all these parameters secures the most efficient fluctuation of the orientation zone inside which the testee's research activity unfolds.

The volume of the orientation zone also changes when a specific situation within the contents of the continuously progressing game is examined. Between the moment when information about the opponent's move is first received and the final decision is made, one can distinguish (naturally, when activity is sufficiently extended) the rotation of certain research action stages, from cursory tactile examination of a considerable number of squares to a lengthy registration of one single square, with these stages at times repeatedly succeeding each other. A characteristic feature of the search dynamics at an individual stage is a gradual (in terms of time) narrowing down of the search zone. When the stages alternate, the testee repeatedly returns to touching the same situation element: one and the same situation element is "considered" in the context of ever new interactions and relationships depending on the particular task facing the subject at a given stage of research. Greater or lesser scope of search activity and the alternation of the stages noted are determined by the results yielded by earlier examination of the situation. This makes the subject revise the particular tasks he seeks to accomplish. The overall problem-solving process is an active self-regulatory search.

Analysis of the tactile activeness displayed by blind chess players in the course of the game has revealed relationships that are essentially the same as those disclosed when studying eye movements, and this heightens the accuracy and dependability of the results and conclusions. However, it is research into tactile activeness that has made it possible to make a more detailed analysis of thought activity.

It was directed, above all, at studying the mechanisms regulating the progress of the problem-solving process when a large number of objective possibilities exists. The scope of tactile

activeness was estimated on the basis of two parameters: 1) the overall number of chessboard squares examined by the subject before arriving at the final solution; 2) the overall number of registrations of the squares before finally deciding on a practical (final) action. Detailed analysis has shown that the second parameter is not identical to the first, and, what is most important, is a subtler indicator of the search's scope (for instance, in two different situations, one of the testees studied 38 squares each time, but in the first case, 86, while in the other, 144 registrations were recorded).

In a series of experiments, a cyclographic recording was made of each of the two blind chess players' tactile activity (under the rules of the game for the blind, each player is allowed to touch the board only when choosing a move). Such dual registration was necessary to make the most extensive analysis possible into a person's activity in a game situation, to approach it as a process of interaction of at least two people, as a specific form of *communication.* With reference to the specific conditions of the experiment, the question had arisen concerning the correlation of each of the two chess players' search activity. This act of comparing also helped reveal the vital characteristics of man's search activity. The starting point of analysis was the fact described earlier, i.e., that in dealing with a problem involving the choice of a move in a game of chess, the testees never analyse all situation elements. They invariably single out an orientation zone which restricts their tactile activity. The volume of such a zone may vary depending on a number of conditions. Psychological mechanisms determining the scope of the search were studied.

The checking mechanism. This is one of the principal mechanisms of regulating search activity. Each situation change (the opponent's move) is checked against the previously formed senses which anticipate the change (i.e., the opponent's actions). In the event of coincidence, the search is substantially narrowed down, while absence of such coincidence extends it. The senses being formed have a complex psychological structure. Above all, they are characterised by definite capacity established strictly objectively on the basis of research activity which in our experiments has a tactile nature. This research shows which of the opponent's moves the testee rehearses and which can consequently be placed into the category of the anticipated. Analysis has shown that the number of such senses may vary within the 1 to 8 range. It has transpired further that in the cases when the testee has formed a number of mean-

ings, "rehearsal" of the opponent's moves may be executed in a variety of ways manifesting itself through the following parameters: a) a specific move may be rehearsed a varying number of times; b) rehearsal may involve different types of movements: in some cases, these are slow movements with the finger registering certain situation elements while in others, these are quick movements without lengthy registrations. These two parameters (frequency and character of rehearsal movements) were used to assess the subjective probability of the testee's anticipations. When the move was rehearsed three or more times, the anticipation was qualified (conditionally) as a high-probability, and less than three times—a low-probability one. Slowed-down movements were regarded as a sign of high-probability anticipations. Verbal reports have borne out the soundness of this interpretation of the nature of rehearsal actions. If the testee formed several anticipations, one can single out those with a higher degree of subjective probability. The number of such anticipations is either two or one (very rarely three). Low-probability anticipations may also be subdivided into 1) discarded anticipations; 2) anticipations in subsequent situations, with their subjective probability increasing.

Let us cite some statistics: in 24 situations under analysis, 86 anticipations were recorded. In 19 cases, 24 anticipations fell into the high-probability category, while the remaining 62 had a lower degree of probability. Out of the 62, 43 anticipations were discarded and never used at all, 19 were transferred to subsequent situations, their subjective probability having been increased (from 1-2 to 6-7 rehearsals). The depth of the transfer was in this case from 3 to 7 moves.

Since the system of anticipations of possible situation changes has a complex psychological structure, the next in turn situation change (the opponent's move) may be related to this system in various ways. It either does not coincide with any of the testee's anticipations, or coincides with the only one anticipation. If a number of anticipations have been formed, the move may coincide either with a high-probability or a low-probability anticipation. These differing ways in which actual changes may relate to the testee's anticipations determine the differences in the organisation of search activity. When the checking reveals the coincidence of the situation change with a high probability anticipation, the orientation zone is narrowed down to a minimum and comprises an average of 21 squares and 41 registrations. Such a coincidence occurred in 8 cases out of 24. In 5 cases, the situation changes coincided with the low-probability

anticipation. The orientation zone was substantially expanded and consisted of an average of 37 squares with 157 registrations. The largest volume of the orientation zone is observed whenever the situation change fails to coincide with any of the evolved anticipations. In such cases it embraced an average of 45 squares with 178 registrations.

The results yielded by checking the situation changes against the system of anticipations determine the scope of the search, i.e., this system constitutes a mechanism regulating the progress of the search. The system of anticipations acts as a dynamic formation which has a definite volume, structure and a scale of subjective probabilities.

Forecasting the conception. Let us examine in more detail just *what is* being forecast. That which the testee has to deal with is a situation change, the opponent's next action aimed at transforming the situation (move). This action has a certain objective meaning which is a sum total of the objective results (both direct and indirect) that arise in a situation when this action has been accomplished. A move may have a number of meanings, since it has several consequences and fulfils several functions (e.g., the defence and the attack function simultaneously). The objective meaning of a practical action becomes independent of the subject who performed this action.

In the context of game tasks, situation changes are not accidental occurrences but the product of the opponent's rational actions, whose interests stand directly opposed to those of the other side. Apart from its objective meaning, any situation change is characterised by the operational sense it has for the subject who is implementing it. The action's meaning never fully coincides with its sense. When making a move, the player never takes into account (this being impractical) all those objective changes which this move will introduce in the situation. He always has only some of these changes in mind. The latter constitute the sense of a given action for a given person. In this context, sense is a subjective formation correlated with a concrete person.

The operational sense of a given specific action can be described on the basis of objective parameters, proceeding from research activity actually executed by the testee, on the basis of two formal indicators: depth and volume. The depth of operational sense may be provisionally conveyed by the number of moves to which the testee anticipates the situation changes which he seeks to accomplish. Volume is expressed by the number of directions in which the testee rehearses his activity. The volume

and depth of senses are dynamic characteristics, which vary depending on the stage of activity and the periods into which a given stage is subdivided. As distinct from the concept of "operational sense", the concept of "goal" registers only those anticipated action results which are registered by word.

Experimental research has shown that search activity displayed by each individual player is directed at revealing the meaning of the situation change. Its aim is to forecast the sense with which the opponent imbues one move or another (to forecast search selectivity for the opponent). The testee's research activity aimed at revealing this sense finds its objective expression in rehearsing those potentialities of the piece which the opponent could have had in mind in making his latest move. It is recording tactile activity of each of the two blind chess players that has made it possible not only to control the generation of senses by one of the players but also the degree to which the other player fathoms them (i.e., the correlation of senses).

Penetrating the opponent's senses is a decisive condition of solving the game problems. Naturally, this condition is far from always met. The degree to which the testee fathoms the opponent's intentions determines the scope of his search activity. Thus, if the opponent's senses are uncovered, the testee analyses an average of 23 squares making 50 registrations. If the opponent's senses are still obscure, up to 200 registrations on 45-47 squares may be recorded (in cases when the senses of the opponent are partially uncovered, the testee analyses an average of 34 squares making 153 registrations).

The formation of operational senses and their uncovering may be described as a gradual process of narrowing down the senses of one testee and bringing them closer to those of the other. This tendency manifests itself in objective indicators characterising both opponents' tactile activity, recording which it has become possible to subject the process to analysis. First, there is a gradual growth in the number of squares examined by both players. For instance, in one of the games, the number of squares examined by both players constituted 37 per cent of the overall number by the sixth move, 60 per cent by the seventh, and 70 per cent by the eighth, when the sense behind the white pieces' moves was fathomed. Second, the number of the opponent's variants that were uncovered also increased. While by the sixth move, the blacks uncovered only 2 out of 7 variants of the white, by the seventh move the figure was 2 out

of 4, and by the eighth, 4 out of 4. Third, there was enhanced subjective probability (the number of rehearsals hypotheses concerning the opponent's moves).

Since the operational sense behind the move made by the opponent was not always uncovered, a question of radical importance is just what is done to uncover it and what makes this process more or less successful. The only way to penetrate the opponent's senses, to forecast them, is to analyse the objective meaning of the action, which may be more or less definite depending on the degree to which the function performed by the action is pronounced. Such functions as attack, including checkmate, and defence are the most obvious ones and are easily uncovered. On the other hand, even such a function as "unblocking" (putting into action a piece other than that with which a move has been made) is less apparent. It is easier to uncover the sense behind the moves whose sense, so to speak, stands in relief (e.g., threatening moves). The testee usually acts upon the assumption (based on the experience of previous games) that the opponent's sense is associated with this basic meaning of the move, and this supposition is often confirmed (testees sometimes state that they find it more difficult to play with a beginner, as one is never certain what he is going to do). That is why the nature of the relationships between sense and meaning and the description of the very meaning of action are a factor determining the forecasting of sense.

Individual situations arising in a game are not, from the testee's viewpoint, isolated but act as stages of implementing his idea or plan (forming a certain united comprehensive meaning). The correlation of sense and meaning changes as the implementation of the conception moves from stage to stage towards making the sense of the testee's move more concrete (or narrowing it down). This fact finds a completely definite objective expression: at the initial stage of the elaboration of the plan, the orientation zone is the largest (45-52 squares under examination, with 200-300 registrations of individual squares), while towards the end it becomes substantially narrowed down (17-23 squares under examination with 40-50 registrations). Uncovering the opponent's senses depends on the stage of his implementing his plan. At the outset, the conception is the hardest to understand, whereas at the end and even in the middle of the game, the sense is often completely uncovered.

As was noted, the sense of the opponent's actions is forecast through an analysis of their objective meaning. The lat-

ter is far from always immediately clear, and for this reason, the testee has to engage in special research to analyse this sense. Since the sense of one piece or another becomes revealed through its interaction with other pieces in a given situation, identifying the group of actively interacting elements becomes a means of uncovering the sense of each of the elements (and the situation at large). Identification of this group is a selective action determined by the point at which the piece involved in the latest move exerts pressure. As a result, the point under pressure is revealed, and becomes the starting point in establishing the group of actively interacting pieces.

The dependence of the scope of the search on the uncovering of the opponent's plans (described above) becomes apparent when reducing the indicators used in a whole range of situations to average values. In fact, in individual cases the actual success (or failure) in uncovering the various senses of the opponent may not coincide with the testee's subjective assessment of the correctness of his prognosis. Such assessments have been studied in a series of experiments, in which the testee was requested to think out loud when choosing his next move. Both his locomotor and verbal activity were recorded. When he was confident that the opponent's senses had been uncovered (in actual fact this was not so) dual relationship between the forecast and the actual sense of the action was observed: a) either the opponent's senses were partially uncovered, b) or it was believed that the opponent had put more sense into his action than he had actually done.

Analysis of the control experiments showed that the scope of the search depends, first and foremost, on the testee's subjective assessments, i.e., on his confidence or lack of confidence in the fact that the numerous intentions of the opponent were uncovered. As a result the search was reduced even when the testee mistakenly believed himself successful, and was extended, when he mistakenly lacked confidence in the fact that he had actually managed to penetrate his opponent's meanings. For instance, in a certain situation, when the testee was certain that his forecast was right while actually that was not so, the scope of the search manifested itself in the following indicators: 20 squares under examination, with 46 registrations of these squares. On the contrary, in a situation when the testee nearly completely uncovered his opponent's action but was not sure his forecast was correct, he examined 37 squares making 149 registrations. The most extended search, which lasted

for 20 minutes and included 890 registrations, took place in a situation when the testee had failed to uncover the sense of the opponent's actions and entertained no illusions about it.

An important question is that of the factors affecting the testee's assessment of his forecast as a success or failure when choosing his next move (i.e., before the opponent's reciprocal move). As a rule, the testee continued his search until definitely discovering the sense of the opponent's move, and this sense was accepted as the sense of the opponent's move. Out of 12 situations under analysis, that was the case in 8. In 5 cases out of 8, the forecast actually coincided with the opponent's plan of action.

Another major factor affecting the testee's assessment of his forecast as correct or erroneous was the soundness or fallacy of his forecasts made in previous situations. It was established that if the testee made correct forecasts three or four times running, the next time he might make very few attempts to analyse the sense of his opponent's move but simply transfer the hypotheses that had "worked" in the previous situations to the next one. Confidence in the soundness of his forecast ceases to be based, as it were, on the results of his activity. As a consequence, errors begin to crop up in the forecast. It is worth noting that, as distinct from cases when the forecast proved correct, opposite cases (unsuccessful forecasts) are usually not repeated, since after a failure search activity substantially expands, specifically, through a more detailed analysis of the intent behind the opponent's actions. In a situation when the testee failed to discover a pronounced sense of the opponent's action and was uncertain of his forecast (no matter whether it was actually correct or not), the testee sometimes resorted to temporising. This acted as a sort of compensation, a way of adapting to a most uncertain situation.

Thus, forecasting is aimed at uncovering the meaning behind the situation changes, and the scope of the search directly depends on the testee's assessment of his forecast as sound or not. In turn, these assessments depend on a number of factors, which have been earlier described.

Pre-planning. Analysis of research activity preparing the choice of the next practical action (move) in a game situation shows that apart from the relatively independent stages in checking the situation changes against hypotheses and forecasting of the intentions, a specific stage, that might be clearly identifiable in a person's activity, is that of planning one's own actions in the situations to follow. The situations occurring

in a game fall into two categories: those in which a plan is being evolved, and those in which a previously evolved plan is being implemented. In the former, the scope of the search is characterised by the following data: an average of 46 squares under examination and 223 registrations, and the latter, an average of 23 squares and 51 registrations. Thus the previously evolved plan acts as an important factor of reducing search activity in subsequent situations.

The testee's tactile activity makes it possible to observe consecutive rehearsals of his actions possible in subsequent situations. To distinguish them from the verbal list of actions, let us call them "pre-planning". The products of this process, i.e., the "lists of actions" in subsequent situations created by the testee, differ in structure. The reference is to two types of "pre-plans", which we shall provisionally call "rigid" and "dynamic", and which are, at the same time, consecutive stages in the process of planning activity.

"Rigid" pre-plans display a definite consecutive alternation of moves rehearsed both for oneself and the opponent, insignificant depth (4-6 semi-moves) and, most important, expectation that the opponent will respond to each of the testee's moves by just one move. In other words, the testee proceeds from the premise that he possesses precise knowledge about the opponent's reciprocal actions. In case of this type of pre-planning, activity is purposeful and selective in the highest degree. However, the plan easily falls apart if the opponent's reciprocal move is not what has been expected.

The second type is characterised by considering many possible directions in the testee's activity (up to 8), with the depth up to 20 semi-moves, and also by the fact that a move being evolved is viewed in the context of several possible reciprocal moves of the opponent or no moves at all are dealt with. Analysis indicates that the structure of the plan is determined by the testee's subjective assessments of the success or failure of his forecast of the opponent's senses. Only when he is certain of having uncovered them does the plan assume a "rigid" character. Vice versa, in cases of uncertainty, the plan retains the characteristics that have been described earlier. Thus, in one of the games, when the eighteenth move was being prepared, 8 variants of a plan were registered, and from 2 to 5 of the opponent's moves to a single planned move considered; in another case, in 10 out of 24 variants, not a single possible move of the opponent was considered. Uncovering the opponent's intentions is, to a large extent, a primary selection of one's actions,

outlining the zone of search for one's own possibilities.

Analysis of visual search revealed a specific tactic of re-examining individual situation elements. The same tactic was expressed in tactile search. This is another proof of the universal nature of the described regularity both in making a forecast and evolving a plan, i.e., the operational senses of the situation, its elements and the actions involving them, are developed. A change in operational senses is a result of special research actions aimed at involving one and the same situation element into a new system of interactions. At the stage of the testee's mental activeness under analysis, these actions have an external and sufficiently extended character: rehearsal of certain moves exteriorised through the sense of touch. The development of operational senses takes place, as a rule, not only inside an individual isolated situation but embraces a whole range of situations. However, the sense of a specific move expands through the involvement of a new system of interacting pieces that has objectively arisen in a situation. This example clearly reveals the two basic and interlinked tendencies: extensive transfer of the results of research activity from the preceding situations to the following, as a consequence of which the situations, as seen by the testee, become united, on the one hand, into definite groups on a sense basis, and on the other, new interactions of pieces emerge.

The stages of complex search activity, which precede the choice of practical action, may, in a number of situations, be reduced. The overall process of choosing a move assumes the following aspect: from ascertaining the coincidence of the situation change with the forecast to making the final decision. However, such a reduced form of problem-solving is a *result* of previously extensive activity (which has included forecasting of the intentions of the opponent's actions and "pre-planning" of one's own actions). To sum up. Let us say that the mechanisms of checking, sense forecasting and pre-planning act as functional mechanisms which regulate the problem-solving process. Sense is an experimentally controllable variable which determines the direction and scope of a person's complex search activity.

§5. Relations Between Verbalised and Unverbalised Components of Problem-Solving

The cyclographic method of recording the blind players' tactile activeness augmented by the more traditional method of

thinking out loud has opened up a unique opportunity to record and analyse the relations between the verbalised and the unverbalised in the actual process of solving a complicated intellectual problem. Analysis has been carried out of a blind chess player's (grade II-I) tactile activity in solving a chess problem (two moves). The problem-solving took 55 minutes and was successful. Comparison of tactile activeness with that of thinking out loud made it possible to pose the question of the correlation between the unverbalised senses and the verbalised products of the testee's work.

Analysis of the recordings of thinking out loud reveals the, so to speak, classic phenomenon of the sudden emergence of "ideas", or verbalised plans, which give rise to the crucial points of the overall process. For example: "...No, I don't seem to be able to do anything ... anything at all... o-oh... a-ah... Let's try this... I've got it!" Further on, the recording indicates that what the testee has thought of, i.e., his plan, is associated with the possibility of moving one of the pieces to the next square. Thus we really do have here the classic phenomenon of perception of the idea or principle of the solution and, if we restrict ourselves to the data yielded by this one recording, this act is really perceived as sudden. In analysing creative thinking, the major link was supposed to be that of finding the principle, the basic idea, the plan of the solution. Frequently, this act is described as a sudden one, not directly stemming from earlier activity, and is further characterised as intuition, perception of the solution, which is supposed to be the antipode of analytical, or discursive thinking.

Analysis of tactile search has shown that the nature of this process does not correspond to its appearance, that tactile activeness prepares the verbalised reflection of the situation elements' properties. Preparation of the "sudden" emergence of the verbalised product manifests itself in vigorous search actions and the formation of unverbalised operational senses of elements. The general rule can be formulated as follows: verbalised products, including those which act as the principle of solving a given problem, are the result of complex research activity (establishing interactions between elements thus revealing their properties), which precedes the emergence of these formations and creates mediating products in the shape of unverbalised senses.

In solving a specific problem, a change and evolution occur in the unverbalised operational senses of certain situation

elements. This takes place not only in the process of one element directly influencing another and the change in these interactions but also as a result of the influence mediated by another element (essentially, we have here the phenomenon of secondary mediation, as it were). This mediated interaction (an empty square may serve as the mediating element) becomes possible only after the formation (primary) of the unverbalised senses of the interacting elements (interaction of previously formed unverbalised senses of elements). The fact that the senses of a number of situation elements interact, indicates that in a situation, the elements form definite functional groups. Identifying such groups makes it possible to change and develop the unverbalised sense of the situation elements.

Verbalised reflection of the properties of the same situation element may also change in the process of problem-solving. This change would also seem sudden if one is to limit oneself to the data of thinking out loud. It has been traditionally described as "reassessment". A comprehensive analysis of verbalised and unverbalised activeness in the process of problem-solving has revealed that not only the emergence of verbal registrations of an element's certain properties but also the change and development of verbalised reflections, are always mediated by the development of unverbalised senses. Naturally, not all situation elements have their senses developed. Once evolved, the senses of some remain unchanged throughout the entire problem-solving process. One of the reasons for this uneven development is that the elements' functional "load" varies depending on the situation.

Problem-solving presents itself as a complicated process of functional development. It appears that this development can be understood only if one considers it within the overall structure of problem-solving. The solution of each individual problem is subdivided into qualitatively differing stages: the stage of solving the problem, and the stage of proving that the discovered principle is sound (verification). The first stage is quite complex: examination of the situation, formation of specific attempts at solution, re-examination of the situation when the target has not been attained (the analysis of conflict), new attempts to find a solution.

An attempt at solution is a specific structural unit of the activity aimed at solving the problem, of orientating-research (in the present case, tactile) activeness, which precedes the physical changes in the situation. A specific attempt at problem-solving incorporates a clear-cut sequence of rehears-

als of possible, both dependent and independent, situation changes (moves) effected in order to attain the required result: one's own move—the opponent's possible moves—one's own moves and the opponent's reciprocal moves. Individual efforts differ in the number of the opponent's responses to one's move and the number of one's own moves rehearsed after the opponent's move. Occasionally, only one move is examined in each link of the attempt. All in all, the problem under analysis involved 15 clearly distinguishable attempts. Each attempt produces a certain result, certain interactions in the final situation, which constitutes the objective meaning of a given effort.

Tactile rehearsal of the attempt is preceded by some preparatory work, i.e., the establishment of certain interactions of elements, a rehearsal of a possible transformation of the existing situation. Such transformation of the situation is made immediately concrete through the unverbalised sense of a definite element, or, to be more precise, through some of its dominant (or most expected) characteristics—interactions that are rehearsed not less than three times. The testee's subsequent activity within the attempt proves to be actually linked to precisely this interaction of elements and is executed for the sake of its realisation; this interaction constitutes the attempt's operational sense.

Preparation of an attempt may include two components. The first, the formation of the sense of the attempt itself, determines the progress of the second, the formation of the unverbalised senses of the specific situation elements. A significant feature of the organisation of research activity is that the sequence of forming unverbalised senses is not dependent on the sequence of moves in the attempt itself.

Rehearsal of an attempt highlights a certain result which the testee analyses. The control movements which make this possible may vary as to range. The result received in the course of an attempt and which was not expected assumes the function of the next attempt's sense. Consequently, the sense of a subsequent attempt may be formed in implementing a preceding attempt. In these cases, preparations for the next attempt consist in forming unverbalised senses of elements which directly interact with the plan of the attempt. The operational sense of the attempt is a factor of the interrelation of individual attempts at problem-solving. When the testee discovers lack of coincidence between the attempts' meaning and their preliminary operational sense, this serves as the source of future search.

Apart from rehearsals of attempts at problem-solving, re-

search activity has another structural unit, the stages of the *situation's investigation.* At these stages, research activity does not yet have the nature of direct attempts at problem-solving. Thus, the testee does not rehearse alternately either his own or his opponent's moves but analyses the functional properties of the situation which often does not have the form of a move directly realisable in the given situation.

Primary examination of the situation includes two stages: getting an idea of the composition of the situation elements and their spatial positions (perceptual activity proper), and the establishment of the functional interactions between specific situation elements. These stages differ in a number of objective features characterising the touch movements of the testee's finger: when he is acquainting himself with the spatial position of elements, the movements are faster; the finger moves along the files and ranks of the chessboard, whereas in establishing functional interactions, the movements slow down, individual elements are registered, and the finger moves between squares which actually interact functionally.

At the stage of primary examination of the situation, rehearsal of functional interactions is reduced mainly to the establishment of interactions between some of the elements and the opponent's black king (the element which has to be involved for the problem to be solved). As a result the unverbalised sense emerges (lack of mobility). If the overall situation objectively contains a multitude of different functional interactions, which constitute its objective meaning, the operational sense of the situation as seen by the testee is formed by the specifics of the black king's position and the pressure on the squares inside the checkmate zone. This situational sense has determined the area and the direction of subsequent attempts at problem-solving. Thus, the situation element, the attempt at solution, and the examination of the situation are characterised not only through their objective meaning but also through the operational sense they have acquired for the testee; we thus have an entire hierarchy of senses.

The stage of primary investigation of the situation is immediately followed by a series of attempts on the part of the testee, with the result of each revealing the limited character of the initial sense. Then comes a special stage of the situation's *re-investigation*, which is characterised by the same features as the stage of the initial investigation, i.e., by the absence of actual attempts at solution, and the establishment of the situation elements' functional interactions. At the

time when the situation is being re-examined, research activity reveals a number of its major aspects, which describe its meaning (primarily, the obstacles in the path of attaining the goal). In the course of earlier research activity (rehearsal of attempts), a certain characteristic of a definite situation element becomes apparent, with which the re-investigation of the situation becomes associated later. This defines the areas of establishing functional interactions and, consequently, may be regarded as the sense of the re-investigation. As a result of the re-investigation of the situation, a new and enhanced (as compared to the results of the primary investigation of the situation) sense of the situation is formed. This determines the subsequent series of attempts by creating a specific task.

In a word, the stages of the situation investigation and re-investigation constitute a specific form of research activity (as do the specific attempts at problem-solving).

Analysing the records of the process of verbal discourse one can observe that the unverbalised senses of the situation (and of re-investigation of the situation) find subsequent expression in speech. Just as there exist verbalised and unverbalised reflections of situation elements, similarly there is a verbalised and unverbalised reflection of the situation at large. Verbalisation is a *generalised* expression of unverbalised senses of the situation (and of re-examination). For example, the unverbalised sense of a situation that had evolved as a result of its primary examination was expressed in speech in the following way: "the king (black) is practically blocked ... there is nowhere it can move". The corresponding unverbalised sense of the situation emerged as a result of an extensive examination of the black king's interactions with other situation elements. Not a single one of these interactions was expressed in speech. The same can be said about the verbalised product of re-examination.

An important fact discovered was that the sense of an attempt at solution is not verbalised. It continues to exist only at a level objectified through tactile activity, and plays a major role in forming the attempt as a whole.

As a specific problem is being solved, not only the situation elements' senses are developed, but also that of the situation at large. Just as re-investigation of individual situation elements is an objective indicator and factor of these elements' sense development, in the same way re-investigation of the situation is an indicator and factor of development of the situation's sense.

As different types of senses (of the element, of the attempt, of the situation) and the different levels (verbalised and unverbalised reflection) are distinguished, the question of the selectivity of search activity is posed differentiatedly in relation to each of them.

The unverbalised sense of the situation element does not reproduce the entire objective meaning of this element. A certain part of this sense is always distinguished. This is in fact the expression of the element's sense. A significant role in the selective character of the formation of the unverbalised sense of a certain element is played by the range of already evolved senses (of other elements, of the attempt, of re-examining the situation). The process of forming the unverbalised sense of a certain element is mediated by the sense of other formations.

The distinction between unverbalised senses and the verbalised products has posed the question of the correlation between the volumes of these formations. It has been found that *an element's unverbalised sense always possesses greater capacity than its verbalised equivalent.* The criterion in choosing the characteristics of the unverbalised sense when translating it into the verbal plane is the interaction of the unverbalised sense with the already evolved senses of various types (the meaning of other elements, of the attempt, of re-investigation). Another criterion is the subjective probability of the element's functional characteristic rehearsed by the testee (determined on the basis of frequency and character of the movements rehearsing some functions or others). Records of the verbal discourse confirm the soundness of this interpretation. It turned out that translated into the verbal plane are mostly high-probability characteristics of the verbalised sense, while the low-probability ones continue to exist exclusively at the level that is objectified through tactile activeness.

The scope of search activity varies depending on the stage of the problem-solving process. The greatest scope was observed at the stage of primary examination of the situation, but even then, the testee's research activity was selective. The selectivity was determined by the sense of the situation's investigation. Similarly, the selectivity of the situation's re-investigation is determined by the sense of re-investigation. It is expressed in the testee's investigation of a limited section of the situation and his correlating of the interactions established in this section with the sense of the re-investigation. The volume of the section singled out for re-investigation gradu-

ally narrows down as the senses of the elements that interact with the sense of the re-investigation are being formed.

Formation of the attempts at solution rehearsed through locomotor activeness is also selective, and this selectivity is determined by the sense of a given attempt. Individual attempts at solution are organised into a larger unit of research activity, a series of attempts, which is also selective. A series is formed in a restricted section of the situation, and involves examination of the elements which are constantly included into the attempts. The selectivity of a series of attempts is determined, above all, by the sense of the situation as a whole. The greatest selectivity of the attempt can be explained by the transfer of the senses of the elements evolved in the course of the previous attempts to subsequent attempts.

By operating the sense of an element that has emerged during one stage of problem-solving at another stage of the same process it is also possible to cut down the repeated rehearsa of the elements' senses and even reduce the very rehearsal of the elements' potentialities. In the latter case, the move is not rehearsed in full. Its trajectory is outlined only partly. The transfer of sense is a major source of enhancing the selectivity of research activity in the problem-solving process. Generally speaking, the selectivity of the various forms of research activity is determined by the different types of senses that are being evolved, which form a complex hierarchical subordination and interact in a most complicated manner.

Verbalised reflections of different types exert an influence on the process of tactile search, an influence which varies depending on the type. The verbalised sense of re-investigation determines only the most general direction of tactile search, while the unverbalised sense of the same type singles out a specific zone within which interactions are established. Inside this zone, an analysis of the elements' functional potentialities remains relatively diffuse up to the moment when there emerged a verbalised reflection of an element's properties, a reflection which interacts with the unverbalised sense of the re-investigation. After the formation of the verbalised product, the analysis of the elements' functional potentialities becomes more concrete and purposeful. The active role of the verbalised product also lies in its greater capacity for being transferred from one stage of search activity to another. The verbalised

products of the testee's research play an active role in the organisation of further search.

The search for solution is sometimes represented as a "game tree" in game tasks. The branches correspond to the various possible moves, while their tips, to the positions in the game. The lowest point represents the initial position, and the highest, the positions with which the game closes. Each game may be graphically represented as a non-ramified chain of adjacent segments which links up the initial position to one of the final ones.

Analysis of the relation of the actual search for solution to the "game tree" has shown that the latter does not represent the interactions between elements that are not actually a move (e.g., interactions between the pieces of the same colour). Such interactions contain, as it were, potential moves which could be executed when certain conditions have emerged. A substantial distinction of the actual search from the "game tree" is determined by the fact that the latter merely registers the sequence of the moves, *preparation* of which does not find full expression in the "game tree". This preparatory work amounts to forming the attempt's unverbalised senses and the situation elements' senses. Sense formation takes place, specifically, as a result of establishing interactions that are not in the nature of a specific move. Therefore, the "game tree" only reflects the result of the preparatory work.

In the "game tree", the attempts are represented as separate branches. However, in actual search activity attempts are not isolated but are connected by a meaningful link. Neither does the "game tree" reflect the complicated relationships between the two levels of research, verbal and non-verbal, and the distinctions between these two levels (for instance, attempts may be realised only at the level objectified in tactile activity). The development of individual sense elements and of the situation as a whole also does not find expression in the "game tree".

The "game tree" is a summary product of really progressive search activity, but it does not represent the processes that have given rise to this product. At the same time, the "game tree" reflects some of the roughest characteristics of the problem-solving search. That which the testee does not at all consider is naturally absent in the "game tree". What is represented are the distinctions in the degree of the search's systematisation at the various stages of the problem-solving process, i.e. finding the solution and proving its correctness.

Visual analysis and formation of verbalised actions. Fur-

ther study of the correlation between the conscious and the unconscious in thought activity has been carried out using the data provided by comparative analysis of thinking out loud and visual examination objectified in eye movements when dealing with one and the same intellectual tasks.

The following parameters were investigated: a) the number of elements in the conditions of the problem which the testee has pointed out and actually studied in the process of visual search; b) the overall number of times the testee has named all the elements and investigated them in the process of visual search; c) the number of interactions between elements, including the actions named by the testee and executed in the course of visual search; d) the number of times an action was named and rehearsed in the course of visual search.

It has turned out that in dealing with a task, the testee named 12 elements only 44 times, while visually registering 33 elements 350 times. Eleven moves were named 18 times and interactions of other types were not named at all. At the same time, the eyes moved from element to element 350 times, as a result of which various types of interactions were established between them, with over 200 being rehearsals of possible actions that can be regarded as trial actions in a situation, as unverbalised hypotheses. The largest number of lengthy registrations was made at the stage when a generalised solution was being evolved and made concrete. They were always later verbalised. They also occurred at the stage when a hypothesis was being checked against the generalised solution or the task's general goal, which were also invariably expressed both in the form of visually established interactions and verbally definite results and goals. Visual registrations were absent at the stages of analysis and assessment of the situation and at the various stages of verifying the hypothesis under discussion which functioned as the verbal result of its acceptance or rejection. It has been discovered that the number of lengthy registrations and, correspondingly, average-length registrations tended to increase at the stages when those hypotheses (senses) were being formed which were transferred from the visual plane of thought activity to the verbal. The objects of lengthy registrations were the elements which later formed the sequence of actions (hypotheses) named by the testee.

It is possible that in the course of lengthy registrations, the testee checks the results of activity manifested through eye movements against the verbally formulated hypotheses. An increase in the number of lengthy registrations at the stages

preceding verbal formulation of the hypotheses is associated with other features of eye movements: the emergence of small-amplitude leaps (1-3°) and shiftings of the eye. Analysis of the situation, verification of the earlier evolved hypothesis and review of the variants associated with it are characterised mostly by large-amplitude saccadic eye leaps.

The formation of unverbalised senses (hypotheses) precedes their verbalisation. Only some part of the actions (rehearsals) is verbalised. Often, only the results of the actions are verbalised, while the other structural components of the actions remain at the level of visual analysis. Individual actions and aggregate actions traced in studying eye movements do not find verbal expression at all. The goals are the criteria of verbalisation, but they are themselves transformed in conformity with the results of visual analysis. Constantly occurring in the course of problem-solving is the correlation of actions executed at the various levels of thought activity. The structure of visual search changes under the influence of the verbally formulated hypothesis: the number of elements with which the testee is working is reduced, and precise selectivity and purposefulness of interactions established between them appears. Verbalised hypotheses act as mechanisms regulating the structure, scope and direction of actions performed at the level of visual analysis, as criteria of selection and assessment of these actions. Unverbalised senses retain their regulating function: they narrow down the search, regulate the process of reflection of significant properties and relationships, and turn the results of visual search into the goal.

General results of research into unconscious components of thought activity and their relationships to the conscious. To sum up. Microanalysis of non-verbal forms of the subject's orientating-research activity (on the basis of eye movements and tactile activity) has shown that:

1. The overall volume of unverbalised activity (unconscious work) considerably exceeds that which finds expression in the oral report and even in the testee's thinking out loud.
2. Unverbalised research activity is selective, its volume and composition are subject to change depending on a number of factors.
3. Formed on the basis of orientating-research activity are unconscious psyche reflections (unverbalised senses) of the task's conditions and its individual elements and of whole groups of situations, which are usually broader than their verbalised equivalents.

4. Unconscious psychic reflections have different structures, they *develop* as the solution progresses and interact with one another.

5. There is a *transfer* (use) of the results of orientating-research activity from one situation to another (without their verbalisation). As a result, an action may prove pre-orientating, and research activity is carried out with reference to a whole group of situations which the subject perceives as a single whole.

6. Unverbalised activity anticipates the possible situation changes and the results of the testee's own actions to transform the situation. These unverbalised anticipations differ in subjective probability parameters, volume, structure, and sequence.

7. Unverbalised anticipations are associated with the unverbalised reflection of the situation and constitute an important mechanism regulating the scope of the search.

8. In game situations, the testee forecasts the opponent's unverbalised action senses and not only his goals; this is done through uncovering their objective meaning.

9. A difference has been revealed between the organisation of practical and research activity in one and the same situation. The novelty of the situation as perceived by the testee does not coincide with the formal novelty.

10. A separate class of cognitive needs has been singled out which emerge in the course of research activity and are objectified in the products of unverbalised research activity (the theory of problem situations, which is usually developed within the context of learning, considers knowledge as the object of cognitive urge). The structure of the task with which the subject is dealing incorporates not only verbally formulated requisites but also those needs (requisites) which have not been objectified in verbally formulated knowledge.

11. The structure and mechanisms of unconscious psychic reflection change when the standard of mastery over a given type of activity becomes higher.

12. It has been demonstrated that unverbalised activeness may pave the way for a verbalised reflection of the situation elements' properties. Found behind the re-assessment are unverbalised re-orientation in the course of problem-solving.

13. Verbalised reflection may be a summary of unverbalised reflections.

14. Factors exist which determine verbalisation. Among them is subjective probability of unverbalised senses. Verbal-

isation of the sense of individual attempts at solution is the most difficult.

15. Verbalised and unverbalised psychic reflection does not exert the same influence on the organisation of the search for solution, the degree of their transferability from one situation to another varies.

16. The results of visual search turn into the goal.

17. It is necessary to operate with more complex notions of the stages (phases) of problem-solving. The period of unverbalised search for solution is not homogeneous and consists at least of the following stages (there are probably more): formation of the search urge, formation of the unverbalised anticipation of solution, formation of the solution itself in an unverbalised form.

18. A major general psychological result of research was the discovery of new forms of unconscious psychic reflection and new structural units of activity.

Experimental-psychological research into thought activity has shown that 1) it consists not only of processes subordinate to a consciously realised goal but also of processes subordinate to an unverbalised anticipation of future results and the processes involved in forming these anticipations, which, naturally, cannot be reduced to operations; 2) in activity (i.e., in that of which it consists), the second type of processes may have a larger share than the purposeful actions proper.

These concepts formulated above have provided the foundation for the sense theory of thinking. Its further development is associated with the study of the emotional regulation of thinking and goal-formation processes.

Chapter Four

EMOTIONS IN THE STRUCTURE OF THOUGHT ACTIVITY

§1. General Problems of the Correlation Between Thinking and Emotion

The psychological characteristics of the thought process, of thinking as activity, and of orientation in a task would be incomplete without an analysis of the role of emotional processes involved in problem-solving, in the formation of psychic reflection. A study of emotional regulation of the search gives concrete expression to the thesis of the subjectivity of thinking. It is important to bear in mind that it is motivationally conditioned, but this is insufficient. It is also necessary to describe the emotions which reflect the relations between motives (needs) and success or possibility of success of the subject's activity that meets these needs. The distinctive place occupied by the problems associated with the analysis of the relationships between emotions and thinking is determined by the fact that these problems often arise at the intersection of the doctrines about thinking and the doctrines about emotions, occupying a peripheral place in each case.

The existence of and the important part played by emotional processes in cognition were noted by philosophers even before psychology became a science in its own right. They discussed such intellectual feelings as doubt, confidence, surmising, surprise, pleasure, and others. Psychological research into intellectual sensations often came up against great obstacles. They were reduced to cognitive processes. Wide currency was given to the viewpoint which emphasised only the negative effect of emotions on cognition, made an absolute of the instances when reflection of reality was distorted under the influence of emotions (Théodule Ribot's notion of the logic of emotions, Bleuler's doctrine of autistic thinking). Heinrich Maier made an attempt to introduce the concept of emotional thinking, which he contrasted with judgement-forming thinking. Describing it, he wrote that the cognitive process is in this case

overshaded, pushed into the background, the focus being the practical goal, for which cognition is an auxiliary means. Maier subdivides emotional thinking into affective and volitional, putting aesthetic and religious thinking into the first category. According to Maier, religious thought acts are affective inferences (and not cognitive processes). These specific inferences have the following features: direct assessment of known facts produced by the wish to attain certain benefits and avoid certain evils, the sense of dependence with respect to a certain principle, an impulse towards realising an act of faith. Although regarded as independent, affective thinking is characterised in only the most general terms and is interpreted as a type of inference. Maier not only failed to subject emotional and affective thinking to psychological analysis but did not even single them out clearly from the multitude of man's thought processes.

Soviet psychologists Lev Vygotsky, Sergei Rubinstein and Alexei N. Leontyev created the methodological foundations bridging the traditional gap between cognitive and emotional processes, specifically, the chasm between thinking and the emotional (and motivational) spheres. In this context, of major importance are the tenets on the unity of intellect and affect and on thinking as a psychic process being in itself a unity of the intellectual and the emotional, and emotion, a unity of the emotional and the intellectual. Also important are the tenets that thinking as activity is regulated emotionally, which directly expresses its partiality, and the tenet of the general functions performed by emotions. Associated with thought activity (taking part in it) are all types of emotional phenomena: affects, emotions proper, and sentiments (Alexei N. Leontyev's classification). One may also refer to intellectual aggression, intellectual stress, intellectual frustration.

Experimental-psychological research into emotional regulation of thought activity has been launched a relatively short while ago. However, it is already essential to the modern psychology of thinking. The "inner conditions" of thinking are constituted both by the emergence and complicated dynamics of emotional assessments.

§2. Emotional Activation in the Structure of Problem-Solving

Let us look at some experimental-psychological research whose purpose was to reveal the relationship between thinking

and emotions. Primarily at the stage when the plan for a solution emerges and the basic principle is found. This is usually considered the core of the process and it presents the greatest difficulty as far as psychological study is concerned. The testees' intellectual work to solve complicated chess problems (etudes in two or three moves) is a typical example of creative thinking. The solution is not found immediately (rejection of stereotyped patterns is often required) and is clearly divided into two phases: the discovery of the principal "idea of the solution", and verification of its correctness (checking the variants).

The principal indicator of the states of emotional activation was the galvanic skin response (GSR). After a number of control experiments, it was accepted that a decline in skin resistance, as a result of the emergence of a state which the testee in his verbal report placed in the category of the "emotional", might be regarded as an indicator of the state of precisely emotional activation. An event that gives rise to a state of emotional activation, manifesting itself through the GSR, should be perceived as the cause of this state only when the GSR appears not earlier than 1.5 seconds after the original stimulus. In the cases when the latent period is shorter, there is every reason to consider the GSR an indicator of the state which has arisen prior to the event under analysis, i.e., preceding it.

The experiment itself was arranged in the following manner. The testees were asked to solve a task accompanying their work by a verbal commentary. Their utterances were tape-recorded and then thoroughly analysed. The time was limited to 30 minutes. It was forbidden to move the pieces when working out a solution. Finding the final solution, the testee was to say: "The problem has been solved." Taking part in the experiments were grade I chess players who were specially selected on the basis of initial electric skin resistance indicators. The problems presented to the testees were both solvable and complicated enough for grade I players.

During the experiments, the testees were requested to remain as quiet as possible. The experimenter visually checked observance of this instruction and carefully recorded all cases when the GSR had been provoked by causes that were external in relation to the experiment (fot instance, a fit of coughing). Resistance of the testee's skin (palm) was recorded throughout the experiment—before presenting the position, during the problem-solving, and for some time after the solution had been

found. Recorders of the EPP-09 type were used. Resistance scales ranging from 0 to 200 kilohms were employed. A time-marker was fixed to the potentiometer's tape and was synchronised with the sound signal recorded by the tape recorder. The latter also registered the testee's verbal reasoning. As a result, the experimenters received a recording of the testee's discourse with the time intervals marked, and had the opportunity to correlate temporally the dynamics of the GSR and the problem-solving process expressed through speech. This method made possible a second (after recording the unverbalised components of the search) major "breakthrough" in the study of the actual thinking process, which not so long ago had been described as an interaction of operations of analysis and synthesis. After the experiment, the testee was requested to present a detailed written account of his emotional states and the problem-solving search process.

The overall dynamics of skin resistance in solving intellectual problems. Recordings of the background prevailing before the problem-solving presented a variegated picture. If the testee was excited or slightly apprehensive, the curve fluctuated chaotically within a variety of amplitudes. The overall direction of the curve was towards lower skin resistance. When the testee was calm, the curve was fairly even and had a tendency towards greater resistance. If the testee was tense while waiting for the experiment to begin, the experimenter tried to ease the tension, suggesting that the testee should not think about the problem he was about to tackle, and that he should not concentrate on his surroundings. The basic experiments took place only on condition that the testee was fairly calm before beginning. Experiments have shown that the curve recording skin resistance could be different at the various stages of solving a problem or solving different problems: being either relatively even and tending towards greater resistance, or consisting of a series of curves with a small amplitude, or, finally, with sharp and strongly expressed changes in the GSR—decline in skin resistance against a fairly unruffled background. As a rule, when the testees had to deal with complicated problems, diverse combinations of these types of changes were observed. Sharp declines in skin resistance were subjected to special analysis.

It was assumed that sharp declines in skin resistance are associated with the emotional states "urgently" arising in the course of the testee's problem-solving search. In connection with the difference of opinion voiced in scientific writings

concerning the psychological significance of the GSR, special experiments were conducted to establish the psychological significance of the GSR when dealing with intellectual tasks. The testee was instructed to specify the moment of pronounced emotional excitement by a fixed signal (pressing the button on which one of his fingers lay). This was recorded on tape. The muscular effort required to press the button was itself able to produce an insignificant orientating reaction manifested through the GSR. That response was, naturally, suppressed in advance. Experiments involving this sort of self-observation have shown that exact coincidence existed between the sharp changes in the GSR and the agreed-on signal given by the testee. Not a single instance was recorded of a signal having been given without a substantial decline in skin resistance. It has transpired that the testee pressed the button after the GSR had begun to manifest itself. Verbal reports on conclusion of the experiments also indicate that there is a link between the emergence of sharp changes in skin resistance and the testee's emotional state. These data have confirmed that in the experimental conditions being studied a decline in skin resistance indicates emotional activation. The particular research did not attempt to give a qualitative characterisation of emotional states.

The verbal report made after the experiment usually noted that emotional states arose at the moment when the first stage in problem-solving began ("suddenly I saw a continuation I hadn't noticed before", "I got a new idea", "I found the idea of the solution", "it became clear to me that..."). Even the data of these verbal reports revealed, in the most general form, that the point of the emergence of the states of emotional activation was timed to the critical points in the problem-solving process, to the discovery of a new principle of actions, a new direction of the search in the course of intellectual work.

Different types of chess problems require different approaches to their solution. In dealing with one type, efforts to find the problem's "idea" prevail, while another type necessitates technically calculating the variants. It has turned out that the type of intellectual activity (prevalence of the search for the ideas or of technical calculation of the variants) is reflected in the outline of the curve recording skin resistance. If the testee immediately sees the general solution scheme and is certain that he will be able to cope with the problem, the decline in skin resistance is minimal. On the contrary, it

is most pronounced in solving those problems where the stage of search for the solution's main idea is most extended. These data directly point to the link between the states of emotional activation and the creative urge in thought activity above all.

The basic experiments involved comparing GSR dynamics and the testee's verbal discourse made in the context of the exact temporal correlation of the parameters under recording. This made it possible to develop the ideas about the thought process (cases when resistance fell by 3 kilohms and more have been considered). Analysis of the data received as a result of the experiments also indicates that there is a connection between the states of emotional activation and the discovering of a new principle of activity in the course of intellectual work. It also became possible to evolve a more differentiated approach, as compared to verbal report, to the analysis of the link between states of emotional activation on the one hand and the discovery of the principle of the solution, and the structure of problem-solving on the other.

Objective analysis of the temporal correlations between the onset of the decline in skin resistance and the testee's naming of the action with which he associated the principle of the solution or the direction of further search has revealed that states of emotional activation not only coincide with the naming of the new principle of action but precede it on a regular basis.

An analysis has also been made of the temporal correlation between point when the GSR began to shift and the point when emotional exclamations began to crop up in the testee's speech. It has been established that the emergence of the state of emotional activation as a rule practically coincided with the pronouncement of exclamations (Aha! O-oh!). The state of emotional activation was expressed in two ways: the utterance of exclamations and the decline of skin resistance. This fact once again confirms that interpretation of the GSR as an indicator of emotional states is well-founded. At the same time, research has shown that the "aha-reaction", which was sometimes viewed in a biased fashion, is an actually existing psychophysiological fact.

Interjections, just as GSR indicators, usually precede by a few seconds the testee's naming the action conveying the solution of the problem or the direction of further search. The testees' utterances following an emotional interjection and preceding the naming of a specific action are very typical: checking oneself ("stop!"); indications that the testee is close

to an idea that has not yet fully surfaced ("aha!" "this looks like it"); stating the as yet not quite clear result of the search ("there is something there...", "looks like I've got it", "that's it"); expression of doubt ("that's it ... or isn't it?"); the need to test ("let's try this", "now this is interesting"). Only on rare occasions did the testee name the specific move immediately after the exclamation. In the interval between the emergence of the emotional activation state and the naming of a specific action, speech activeness testified to the fact that the search was going on. Emotional activation acts as anticipation of the problem's solution; this state is associated, as it were, with the feeling that success is near. All this means that the phenomenon of anticipation in thought activity has at least three varieties: verbal anticipations; anticipations at the level of unverbalised search, and emotional anticipations.

Temporal correlations between the beginning of the shift in the GSR, which could assume a stepped form, as it were, and the stating of an as yet unclear search result in the verbal plane show that emotional activation, "the feeling that the solution is close", precedes in time even the emergence of indefinite verbal assessments. The beginning of the GSR shift runs ahead of the testee's verbal assessment of the next in turn attempt at solution. The precedence is particularly striking when the testee only gradually arrives at a certain conclusion in the process of calculating and checking the variants, when he is not yet sure that his assessment is correct and his verbal activeness reflects some doubt while skin resistance already begins to decline (the precedence may be as great as 18 seconds). In all cases when the testee had found the final solution of the problem, which coincided with the objectively correct one, the decline in skin resistance preceded his naming the final solution by several seconds.

Thus, objective differentiated analysis of the correlation between the states of emotional activation and the various components of verbal discourse shows that *as a rule, the state of emotional activation precedes the verbal formulation* of the principle of solving the problem, the direction of further search, verbal assessment of the next in turn attempt at solution, and the naming of the final solution of an intellectual problem. Emotional activation repeatedly emerged in the course of solving a problem.

§3. The Function of Emotional Activation

For the purpose of ascertaining the functions of emotional states in the further search for solution, individual cases of problem-solving were subjected to detailed analysis. Among the parameters for which they were analysed was the change in the organisation of activity following the emergence of the state of emotional activation. The following sequence of events is typical. In the course of seeking solution, the point of sharp decline in skin resistance (e.g., the 19th minute) was clearly observable. This was recorded in the report as the point at which it had become "clear" to the testee, there emerged "an idea of the solution". In the process of his discourse, he named the action with which he associated the solution of the problem (hypothesis). The solution was named by the testee only by the 30th minute, while the state of clarity ("it seems I've got it") appeared by the 19th minute. The conviction arises that the supposition is correct, although it is not yet fully clear that this is so. This state was termed "the emotional solution of the problem". The decline in skin resistance, in this case, stood out graphically from the background and reached 14 kilohms. As to amplitude, the magnitude of the response exceeded the magnitude of the orientating response to an indifferent irritant. Emotional anticipation of the plan, which

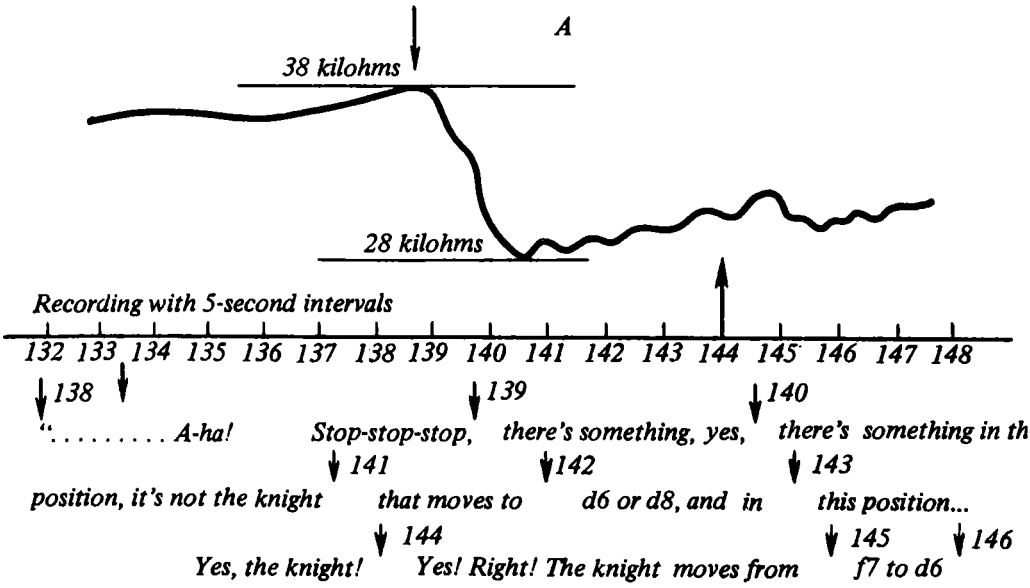


Fig. 7. Excerpt from the record of an experiment investigating emotional activeness in the structure of thought activity. Top line, the GSR; middle, time intervals; bottom, excerpt from the testee's verbal discourse with the five-second intervals marked

was given verbal form, preceded the naming of the action with which the solution was associated by 4 seconds (Figure 7). We see that the emotional response twice precedes the emergence of the solution at verbal level: the naming of the final, the ready solution of the problem and the naming of a possible hypothesis. The first precedence is measured in terms of minutes (sometimes dozens of minutes), and the second, in terms of seconds.

The point when "the emotional solution" emerges divides the overall problem-solving process into two qualitatively differing stages. The change in the process's structure after the emergence of the emotional solution of the intellectual task manifests itself through clearly defined indicators characterising the structure of the testee's verbal discourse. The zone of further search is outlined rigidly. Thought activity becomes more purposeful, with only the possible transformations of the situation (following the singling out of the action) being considered. The actions preceding it are repeated in a stable fixed order. The overall number of action sequences considered by the testee is reduced, as is the volume of research activity: the re-investigation phenomenon in certain situation elements falls off (this re-investigation consists in the involving of one and the same elements into ever new interactions). The falling off of this tactic of re-investigation indicates that changes in the psychic reflection of certain situation elements have ceased. The regularities in the change of search activity that have been revealed (registration of the search zone, reduction of its volume, registration of the direction of the search, the change in the character of search actions) after the emotional solution of the problem prove that emotions perform a definite regulatory function.

In dealing with an intellectual task, emotiogenous zones are shifted, and certain hierarchical relationships and continuity are evolved between them: the existence of one prepares the emergence of another, as well as of the very solution of the task. Together with using emotional experience when forming a hypothesis, one can observe a heightening of the emotional colouring of one and the same action mentioned in a variety of attempts. The colouring of the move that appeared earlier becomes cumulated. The cumulation of emotions and gradual shift of the emotiogenous zone are the conditions that pertain to the very origin, the forming of a hypothesis. When the correctness of a hypothesis is being verified (after "the emotional solution of the problem"), the GSR curve is much more flatter than

during the testee's verbal discourse at the first stage of problem-solving. The declines in skin resistance, which are insignificant in amplitude, correspond to the critical points in verifying the hypothesis. The final naming of the solution is also preceded by a decline in skin resistance.

The "emotional solution of the problem" may also take place repeatedly in those cases when, prior to becoming confident of finding the right solution, the testee had first become certain of the soundness of a solution which was not wholly, although very nearly, correct. It is interesting that there is a coincidence of objectively and subjectively critical points of the search for solution. In verifying the discovered principle of solving the problem, the testee sometimes followed, for quite a while, a false trail. Such search probing was also preceded by an emotional change. However, upon forming a negative estimate of this false trail, the testee returned not to the initial situation of the problem but to a certain emotionally coloured point.

Consequently, in thinking, emotional states perform a variety of regulatory, heuristic functions. The heuristic function of emotions includes the singling out of a certain zone that determines not only the further in-depth search but, also, if it brings to unfavourable situations, the return to some definite point.

Preparations for the emotional solution of a problem manifested themselves in the following phenomena: a change in depth of the emotiogenous zone; formation of emotionally coloured points (sometimes multiple) to which (and not to the initial situation) the research activity returns if it has reached a blind alley after following a certain line; a change in the emotional colouring of one and the same research actions (transition from the neutral to the emotionally coloured, from the emotionally coloured to the neutral, "emotional confirmation of one and the same action"). Sometimes, there is a coincidence of two major characteristics of the problem-solving process: the multiphase or gradual nature of the problem's emotional solution, and the multiplicity of emotionally coloured points to which the search returns. Instances of transition from a neutral to an emotionally coloured action show that emotional responses mature as a result of the research activity, which is characterised by the change in the subjective value of appearing psychic reflections.

In a definite situation, the various actions do not have the same objective value. It is important to bear in mind that in problems which the testee solved, the objectively critical points, the more

valuable transformations of the situation were perceived by him, too, as subjectively valuable actions. This was shown in their emotional colouring. Subjective values acted as a reflection of the elements' objective value. It is this reflection that makes it possible for the testee to cope with a complicated problem. Problem-solving when there is a shortage of time may lead to a reduction of the stage at which the testee systematically proves the soundness of his solution, as a result of which the point of final solution (even if it is objectively correct) may prove to be only an instant at which complete subjective certainty in its soundness emerges. In short, the emotional states expressing subjective value fulfil certain essential functions. Their necessity is borne out by the following observations.

During experiments, cases have been recorded when a testee who had failed to solve the problem later wrote in his report that he could not make himself ponder on it and felt languid and indifferent. A recording of the skin resistance showed that periods of emotional activation were absent. This was most vividly seen in the case of one testee, who throughout a whole series of experiments remained in a state of depression caused by external circumstances. The GSR curve tended to be flat, the testee failed to solve any of the problems he had assessed as "difficult" (occasionally, the first reaction of activation was observed only after he had been informed that the experiment was over; the role of the GSR as an indicator of "attitude" was in this case most clearly pronounced). The goal of another series of experiments was to produce a state of emotional inactivity in the testee and to trace its effect on the efficiency of his efforts. Among the devices used, the following one proved relatively more efficient: the testee was instructed to make his verbal account accompanying the process of problem-solving as monotonous and disinterested as possible. To comply with this instruction, the testee had to tone down his emotions in order to maintain an indifferent attitude. Three problems in this series, indeed, produced a flat GSR recording. The problems were assessed as difficult by the testee and remained unsolved. The "easy" problems were sometimes solved even when the GSR line remained fairly flat, but in these cases, at least one sharp decline in the skin resistance was registered. In another series of experiments, the testee was given the following instructions: "You must, without fail, solve the problem. And do this remaining absolutely calm, and manifest no tension whatsoever. Remember, that we can monitor your emotional state. The moment you cease to comply with our requirements, we shall immediately halt the experiment." One

testee got 13 problems, and it turned out that not a single one had been solved correctly until there arose a state of emotional activation. Consequently, emotional activation is a sine qua non of productive intellectual activity. This conclusion is confirmed by the data of the verbal account: "This blasted machine (the potentiometer) gives one no chance to think", "I can only deal with easy tasks unemotionally, but never with difficult ones". "The need to remain calm prevents me from making a thorough analysis of the variant I have found...".

It would be of interest to mention here that in this series of experiments the testee tried to adapt to the complex conditions by trying to guess the solution without engaging in analytical search work. He began to compete with the device by trying to forestall the GSR shift. Although, naming a hypothetical solution in advance of the GSR proved possible, not a single one of the conjectures turned out to be correct. In a number of problems, the experimenter deliberately violated the conditions of the experiment and did not interrupt the testee's activity after the appearance of a galvanic skin response produced by the effort to guess the solution. In these situations, two out of the four problems were solved by the testee, but only after a decline in the GSR occurred. Control experiments have been conducted which revealed that the mechanism of emotional activation is essential to perform creative and not just any kind of intellectual work. When the testee was asked to do fairly simple sums and to count to a hundred out loud, the GSR curve was fairly flat, with the resistance even tending to rise.

It is clear that a sufficiently definite link exists between the state of emotional activation and the testee's discovery of the basic principle of the solution. A possible interpretation of the nature of this link is as follows. After the testee has found the principle of the solution, a state of emotional activation immediately emerges as a *consequence* of the successful solution. Another interpretation, which appears much less obvious, is this: the states of emotional activation are incorporated in the very process of search for the principle of the solution. Since the states of emotional activation invariably precede the naming of the principle of the solution, the second hypothesis seems more sound. An alternative now appears: a) the principle of the solution is at the non-verbal level and is later verbalised (in this case, activation may indicate that the principle of the solution has been found but not yet verbalised); the state of emotional activation precedes and prepares the discovery of the unverbalised solution. Analysis of verbal activeness in the interval between the

point of the emergence of emotional activation and the verbal naming of the principle of the solution shows that in this interval, the testee's speech does not contain any indications of the principle being found. Herein we merely have the process of its verbalisation. Further it serves to indicate that the testee is still looking for the principle of the solution. The state of emotional activation acts as a kind of unspecified signal of a "stop", points to the area where the yet unknown is to be found, is a general anticipation of the principle of a solution (or final solution). As we have noted emotional anticipation of the principle of the solution is experienced by the testee as "the sensation that the solution is near".

It turns out that the discovery of the principle of a problem's solution is in itself two-phased: first singling out the approximate area of search of the principle of the solution, and then finding the principle. Emotional activation (its most pronounced form) is associated with the first, preliminary phase, which assesses, as it were, the subjective value of the various lines of search. The interpretation, according to which the state of emotional activation paves the way for discovering the principle of the solution and not merely forestalls its expression in speech, is also confirmed by the fact that emotional activation immediately preceding the naming of the hypothesis is prepared by the preceding states of emotional activation (the cumulation of emotions and the shift of the emotiogenous zone).

Further study of emotions that arise in the course of thought activity and take part in regulating it, was directed at resolving the following research tasks: a) revealing the role of emotions in the formation of the solution's general idea; b) tracing the evolution of emotional assessments connected with the situation elements and actions involving these elements, c) ascertaining the role of emotional processes in the transition from non-identification to identification of objectively meaningful actions; d) observing the interrelation of verbal and emotional assessments; e) establishing the degree of coincidence between the subjective and the objective scales of value characteristics. Apart from recording the GSR, the pulse was also taken.

Used in the experiments were chess etudes, with the requisite defined as VICTORY. Formally, it allowed two interpretations: 1) enforced checkmate (which was actually incorrect); 2) attaining a combination of pieces in which checkmate is apparent to a skilled player (an objectively correct variant). The testee's interpretation of the polysemantic requisite constituted the general goal or the basic idea of the solution of a specific problem.

Analysis of the solutions has shown that the testees consecutively evolved two general ideas as to the solution (variants I and II). For a definite period the testees were influenced by variant I. And only after making several attempts they managed to get free from the first variant, which, in this specific situation, was wrong, and formulated the second general idea of the solution. The first idea was, as it were, enforced by the problem's conditions. It emerged as soon as the testee familiarised himself with these conditions, and was associated with the most habitual mode of action (stemming from earlier experience). This idea was not connected with the emotions accompanying the problem-solving process. When the initial situation was re-assessed and a second, objectively correct idea began to evolve, there arose vivid positive emotional activation which preceded the point of transition. Negative emotions need not necessarily be an obstacle to man's intellectual activity, since they may pave the transition to an objectively correct general idea of the solution within the initially objectively incorrect general idea. The formation of the objectively correct general idea is promoted by a positive emotional colouring of actions that are merely vehicles for the objectively correct principle and do not lead directly to attainment of the goal set in the given situation. Positive emotional assessments emotionally "direct" the testee towards an objectively correct mode of action, thus promoting the transition to the objectively correct general idea. The number of attempts at a solution, which realise the second, objectively sound, general idea, is determined by the degree to which the testee has become certain, in the course of earlier activity, that he has found a correct solution.

One of the major features of the activity aimed at solving intellectual tasks is that the testees' assessments (verbal and those expressed in spontaneous vegetative reactions) are subject to change in the course of the search. The dissociation (absence of coincidence) of verbal and emotional assessments, with the emotional retaining a leading and regulatory role, may take place. Emotional assessments may prove more accurate than the verbal. This takes place because a subjective scale of values evolves which fully coincides with the objective scale (pertaining to the situation itself). When the objective and the subjective scales of value characteristics fail to coincide, emotional assessments may, naturally enough, perform negative functions too. A necessary condition of finding an objectively correct solution is the coincidence of the subjective and the objective scales of value characteristics.

Each emotional assessment of an action's generalised value, and of the very action involving objectively meaningful situation elements is prepared by another, which precedes it (except, of course, the first emotional assessment). Emotional assessments of actions involving situation elements may be prepared not only by emotional assessments of preceding actions involving these elements but also by emotionally coloured combinations of such actions which are indirect vehicles, as it were, of objectively correct meanings, as well as by general emotional assessments of preceding attempts at solution, tentative ideas of these attempts, of the actions' "direction", and the conclusions made in the process of search activity. To comprehend the train of concrete emotional assessments of individual situation elements, one must take into consideration the emotional assessments of attempts at solution at large, the assessments of the situation, and the assessments both of the general and the preliminary ideas of the solution. The mechanism of forming the idea of objectively meaningful actions involving the elements under analysis includes emotional responses, which are a product of earlier and a regulator of subsequent research activity.

Emotional anticipation of action or of the sequence of actions is a necessary mechanism for their acceptance as being "correct". Vice versa, lack of emotional anticipation may produce a situation when objectively correct actions and entire sequences of actions are not recognised as such, although they are named in the verbal discourse. A verbally formulated idea of an action that is being performed emerges on the basis of anticipatory emotional assessments, whereas the absence of such anticipations hampers the forming of the idea. The problem's emotional solution is the culminating point of complicated emotional development that takes place in the course of problem-solving.

§ 4. Emotional Memory

Using the classical method of leading (suggestive) tasks and bearing in mind that such a task is only effective after unsuccessful attempts to cope with the main task, researchers have advanced an interesting supposition, i.e., that when the leading task has been emotionally consolidated in advance, it will also have leading effect during the subsequent solution of the main task. Experiments have confirmed this hypothesis. With the existence of considerable emotional excitation (vegetative indicators and a retrospective account have been used to estimate its strength) in the course of resolving the leading problem, it exerts a positive

(leading) influence on the solution of the main problem. The point of discovering the solution of the main problem is preceded (on the average at the 35th second) by the moment when positive emotional excitation appears, which manifests itself in a decline in skin resistance and a quickening pulse. As a rule, the testees noted that at the point when the main task was solved, they had various associations connected with the irritants they were subjected to when working on the leading task, and that this helped find the solution. This happened irrespective of whether the preliminary solution of the leading problem was accompanied by either positive or negative emotions. The emotional consolidation of the principle of the solution contained in the leading problem promoted its actualisation when solving the main task and curtailed the attempts in looking for the solution. Consequently, what we have here is a manifestation of *affective memory*. Emotional consolidation in the course of problem-solving is a manifestation of affective operative memory (it should be noted that it is wrong to reduce operative memory to sensorimotor memory).

In a series of experiments, emotional (negative) excitation was provoked in solving the main task, while the main and leading tasks were presented to the testee in the following order: first the main one, then, after vain attempts to solve it, the leading, and, after the latter's solution had been found, the main one again. It turned out that, having solved the leading task, the testee failed to solve the main one on its second presentation despite the fact that all the conditions characterising the positive effect of the leading action were observed. Negative emotional activation deliberately provoked by the experimenter suppressed, in the process of solving the main task, the emotional activation engendered by thought activity itself. As a result the chance for the emergence of emotionally consolidated experience, that was necessary for a subsequent link-up with the leading task, was blocked, as it were. It thus became possible to chart a way of regulating the search process of problem-solving by using emotional activation mechanisms. Some testees were partially aware of being led to the solution of the main problem.

Hence, experience is transferred from one situation to another not only on the logical but also on the emotional basis. This transfer can be regulated. Emotional consolidation makes it easier to actualise past experience, paves the way for its mobilisation and makes the search purposeful. Emotional experience is one of the mechanisms leading the testee to the solution. It affects the task's restructuring in the process of its solution.

§ 5. Emotions and Unverbalised Sense

One of the works in the field has advanced the hypothesis about the close link between intellectual emotions and the processes unfolding at the unconscious and unverbalised level (with unverbalised operational senses). To check it, a method was used which allowed to simultaneously record (via a cyclograph) perceptual activeness, verbal discourse and psychophysiological indicators of emotional activation (Figure 8). This complex

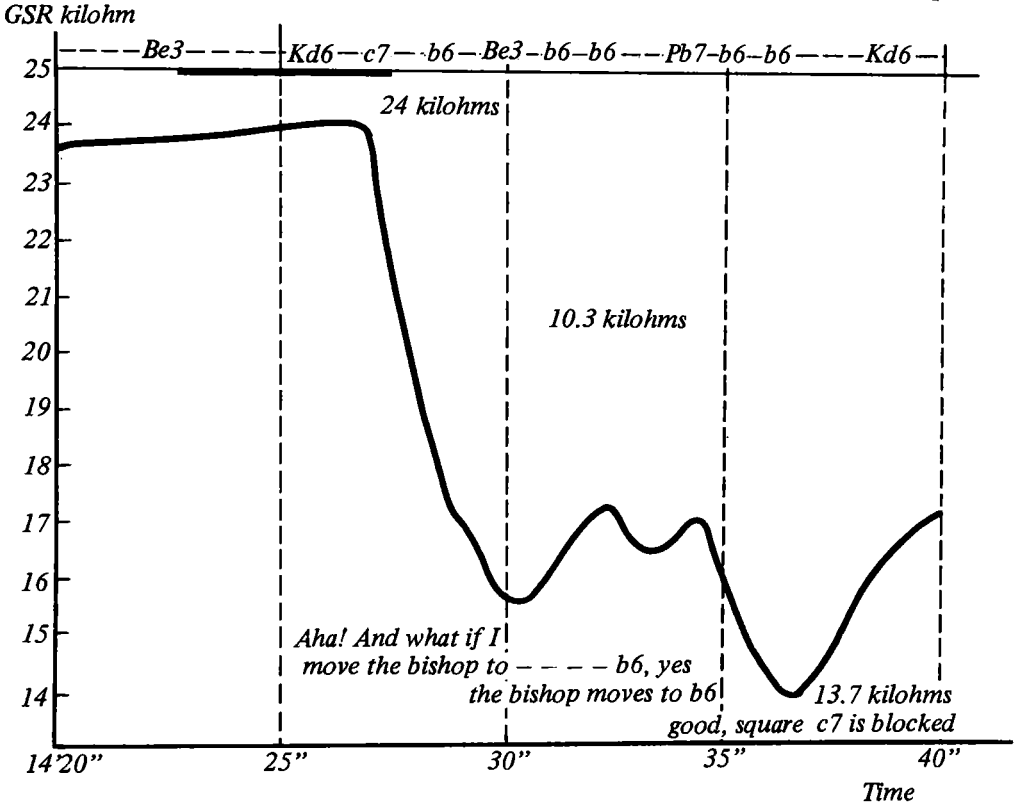


Fig. 8. Preparing the intellectual emotion at the unverbalised level in the course of forming a goal (hypothesis). Designations: top line, a record of tactile activeness using chess symbols; middle, the dynamics of the GSR; bottom, verbal utterances. The arrow points to the outset of emotional activeness with due consideration for the GSR's latent period

recording makes possible a most revealing study of thought activity as a process as compared to other methods used in the mid-1980s. Over 3,000 cyclogram sequences were examined (each registering a 5-second interval), and 251 cases of the emergence of emotional activation were interpreted. Thanks to the time notations, the data illustrating the various indicators were correlated with 0.5 second precision.

In the course of the experiments, the testees did not name their

emotional states as they were unaware of them. The appearance of emotions was indicated by exclamatory interjections, intonation, and vegetative changes. The target set before the testees when giving their verbal reports was being aware of the quality and intensity of the emotional states as well as of their link with certain stages of the problem-solving process. The testees named "the sensation that the solution is near", "certainty", "satisfaction", "uncertainty", "disappointment". Sometimes, the testee failed to immediately link certain actions and their results, thus active recall was required.

The limitation of the phenomenological method, which describes emotions in terms of "surprise", "doubt", "certainty" is that it makes it possible to record only those emotions that are realised and expressed through meanings, emotions that are the product of the testees' special work to classify and categorise the emotional states they experienced in the past. Experimental-psychological research makes it possible to study emotions in the context of actually performed activity, at a level not verbally categorised by the testee. It is necessary to analyse the various levels of objectification and awareness of emotions.

It was demonstrated that a condition of the emergence of intellectual emotions is the development of the elements' unverbalised operational meanings. Based on establishing interactions in tactile activeness, emotional anticipations are included in the process of forming hypotheses and actions proper, in the process of revealing the elements' properties in the transformed situation. Dynamic transitions were revealed from emotional anticipations based on establishing interactions in tactile activeness to "absolute" emotional anticipations (i.e., those that have not been prepared by tactile activeness), which act as preceding signalisation with regard to previously revealed hypotheses and actions reaching the final goal. This means that emotional anticipation itself can be of a different nature. Emotional anticipations of both types occur mostly at the active phases of the thought process, which are at the same time stages of the process of goal-formation.

Delay in emotional assessments with respect to verbalisation is typical of periods when intermediate results are received. In these cases, emotions register, as it were, in the subject's consciousness a certain significance of an already realised and verbalised intermediate result of thought activity from the point of view of the characteristics of the final goal. Intellectual emotions are prepared during the development of the situation elements' operational senses and emerge when these senses acquire a

content that corresponds to certain characteristics of the final goal. The development of operational senses proceeds in two forms: the verbalised and the unverbalised, with the transition of one into another. Intellectual emotions mediate the transition from unverbalised psychic reflections to verbalised ones. However, this sort of transition sometimes does not involve emotional mechanisms, e.g., at the stage when intermediate results are received.

We see therefore that there are two types of transition from unverbalised to verbalised reflection: 1) without the mediation of emotional activation; 2) by involving emotional mechanisms.

The general theory of emotions maintains that an emotion arises on the heels of the actualisation of a motive (need) and prior to the subject's rational assessment of his activity. Such actualisation implies a certain change in the motivational sphere and the emergence of new personalised senses. Emotion serves as a signal of personalised sense. Experiments have shown that as work on an intellectual task proceeds, unverbalised operational senses are transformed into personalised senses. The emergence of personalised "micro-senses" has for the first time become accessible to experimental research.

Also studied was emotional regulation of activity depending on its motivation. Motivation affects the degree of emotional "saturation" of activity and the correlation of anticipatory and registering emotions. In the instances when the internal qualitative-procedural motive dominates, the number of anticipatory emotional assessments associated with the active search and the transformation of the existing situation is significantly larger than the number of registering emotional assessments associated with the achievement aspects of activity. The emotions of success or failure are related to the object in various ways. When the external motive dominates, even insignificant successes and failures (when solving game problems) acquire an emotional colouring. When the internal qualitative-procedural motive dominates, emotional assessments are selectively linked up with the realisation of goal structures or with failure to uncover the opponent's plans. Accidental victories or defeats, even if they are major ones, are not assessed as success or failure.

One of the hypotheses advanced during the study of the emotional regulation of thinking was that concerning the interaction of positive and negative emotions. It holds that as the negative emotional system is activated, a reciprocal activation occurs in the sensibility to positive supporting factors. On this basis, the subject is, as it were, on the alert for the smallest signs of success,

even when partial correspondence between the task's requisites and the results of orientating actions is emotionally estimated as success. Emotional assessment is engendered from the angle of the general idea of the solution, not in the context of individual attempts undertaken in the course of the search. A negative emotional assessment arises only when the idea of the solution at large has not been realised. Individual unsuccessful attempts do not necessarily produce a negative emotional state.

Also undertaken was an analysis of emotional regulation of thought activity in varying motivational conditions. Three structures of activity were compared: 1) the prevalence of external achievement motivation and the setting of concrete goals; 2) the prevalence of internal achievement motivation and the setting of general goals; 3) prevalence of the internal qualitative-procedural motive and the formation of goal structures that incorporated general and concrete goals. It has been shown that these three structures have different types of emotional regulation marked by various emotional phenomena within the system of internal regulation. The role of emotional processes in regulation increases with the transition from the first to the third variant of activity. Depending on the structure of the activity, enhanced significance with reference to personalised sense may be attached either to the achievement aspect of activity or to its object-procedural aspect. The difference in the significance of individual periods of problem-solving is the reason for the specific orientation of emotions in the three structures of activity associated either with active search and transformation of the existing situation, or with the achievement aspect of activity. The specific orientation of emotions makes itself felt in the difference between the components (intermediate goals and results, the use of tactical means) making up the problem-solving process that are estimated as successful or unsuccessful, and in the correlation of anticipatory and recording emotional assessments. The mechanisms of emotional regulation, e.g., emotional consolidation, "leading" or correction, function in different ways in the different structures of activity.

The results of the research described above have made it possible to substantially augment the concept of the "structure of activity". They give grounds for believing that, together with motivational and goal-related formations, it should also include the emotional regulation type. The ideas on the origin of personalised senses and their interaction with operational senses are a component part of the sense theory of thinking.

Chapter Five

THINKING AND GOAL-FORMATION

§ 1. The Problem of Goal-Formation in Psychology

One of the units distinguished when psychologically examining human activity are processes subordinated to the conscious (i.e., expressed in speech) anticipation of a future result of action indirectly connected with the motive of activity. These anticipations are called goals. This concept becomes central only in the psychological study which considers man's conscious activity its principal object, and the principle of activity, the main explanatory principle.

The nature of purposeful activity has for a long time provided a subject only for strictly philosophical study. The struggle between mechanicalism and idealism, fatalism and voluntarism forms the history of the philosophical study of the nature of man's conscious activity. Marxism was the first theory that made it possible to avoid the fallaciously conceived alternative between fatalism and voluntarism and laid the methodological groundwork for concrete psychological study of purposeful conscious actions. Its fundamental principles can be reduced to three main tenets: 1) purposefulness, orientation towards certain goal distinguishes the life of society from the processes under way in nature; 2) the goals are determined by external circumstances and the laws of their change, mastering which man gains an opportunity of using these laws for attaining these goals; 3) there is no complete correspondence between the goals and the actual results of man's actions. Frederick Engels noted: "Let us not, however, flatter ourselves overmuch on account of our human victories over nature. For each such victory nature takes its revenge on us. Each victory, it is true, in the first place brings about the results we expected, but in the second and third places it has quite different unforeseen effects which only too often cancel out the first." Historical materialism attaches great importance to this feature of man's actions in investigating the problem of the

objective character of social laws operating through man's conscious activity.

Pre-Marxian psychology did not pay sufficient attention to the phenomena which fall into the category designated as goal. Thus, William James's *The Principles of Psychology* did not even mention this term among the fundamental ones. The only exception was probably Wilhelm Wundt's *Grundriss der Psychologie*, which proclaimed the principle of "Heterogonie der Zwecke". However, the doctrines of intentional acts, determining tendencies, apperception, anticipating schemes, ideomotor acts, "personalities" and, particularly, the level of aspiration contain valuable material relevant to the field at large.

Modern psychological science has evolved four main positions with reference to the concept of goal.

1. The concept is declared unscientific. This is the stand advocated, among others, by the US psychologist B. F. Skinner, who describes man's behaviour in terms of stimuli, response and reinforcement. Viewed from this position, behaviour loses its purposeful, goal-oriented character, and the very psychological concept turns into an apology of "personality manipulating" current in bourgeois society.

2. Referred to as a "goal" is any useful result for the sake of which behaviour unfolds. No distinction is made between expediency and purposefulness. An example is Edward Chace Tolman's "purposive behaviourism". In the Soviet Union, this use of the term has been made by Pyotr Anokhin in his functional system theory which identifies the goal with the acceptor of action. The glossary of psychological terms with which one of the US psychology textbooks is supplied (written by Ernest P. Hilgard et al.) defines goal as a terminal state, or condition, towards which motivated and consecutively unfolding behaviour is directed, and through which this sequence is completed. This position is typical of naturalistic doctrines which make no distinction between animal behaviour and man's activity.

3. The goal is viewed as a terminal situation *preset* by a formal description and attained in the course of the functioning of a certain system (a technical device, a living organism, man). In this sense, the term is used within the context of cybernetics; the issue of the difference between the "goals" of the functioning of these systems is simply left out of consideration.

4. Goal as a conscious image of future results indirectly connected with the motive. The analysis presented in this chapter will proceed from this concept.

While in psychological literature the term "goal" is used in

a variety of senses, the term "goal-formation", i.e., emergence of new goals in individual or joint activity, has until recently remained in the background. In his time, Sergei Rubinstein wrote that "recognising action as the main 'cell' of psychology means that in action, psychological analysis may discover the rudiments of all elements of psychology". Today we can add "apart from engendering new actions". We believe it important, using the overall pattern of the structure of human activity (activity, action, operation), to distinguish between the level of analysis of action and of activity (incidentally, enthusiasts of the so-called "activity approach" have failed to do so). The problems posed by goal-formation are located between these two levels.

There are several reasons why they have been so inadequately investigated. Above all, this is the much-criticised but still persisting functionalism. The various aspects of the complex goal-formation process have, as it were, been appropriated by different branches of psychology. The emergence of new ideas of the future result is considered in connection with imagination. Prevailing among the images that are "returning from the exile", are those of existing objects, not future results of action. Psychology of thinking draws an important dividing line between what is sought for and what is actually required, the conscious and the unconscious products of activity. However, this valuable research has not been correlated to the theory of activity at large, and has even been opposed to it. The degree of clarity of reflection is examined within the teaching of attention, but this characteristic does not usually embrace the reflection of the future results of an action and is not an object of experimental research within the study of attention, which is still dominated by the interest in the processes of activation and planned formation of internal control.

The category of goal is constantly used in the theory of will, but the very process of formation of the final goal, described as decision-making, is at best mentioned but not treated as a subject for experimental research. What is more, modern formalistic interpretations of "decision-making" as making a choice out of a range of possibilities, in fact cancel the problem of goal-formation. It is also necessary to remember that the problems of will are among the least developed. In analysing needs, primary attention is given to the processes of the emergence of motives and needs as a result of the "encounter" of the need with the object or situation that can fulfil this need, while goals remain in the shadow.

Even the theory of man's action has until recently neglected

the correlation between the anticipated and the actually attained results, the emergence of anticipations, their types, an analysis of their sequence (changes in anticipations depending on the success or failure of earlier actions). Action was often studied for one of the parameters ("goal") and excluded from the context of man's activity viewed as a whole. In describing actions, even some of the champions of the activity approach do not at all use the term "goal" (nor do they differentiate between the cybernetic and the strictly psychological meaning of this term), it has been replaced by the term "the orientating basis of action". However, it is impermissible to use these two terms interchangeably for the following reasons: a) the "orientating basis of action" is clearly discernible in any complex behavioural act, it is not peculiar to conscious activity; b) in elaborating the term "the orientating basis of action", the accent is on the existing conditions and not future results. Man's "orientating basis" may be either verbalised or unverbalised (or may be a synthesis of both), may refer to an existing situation or the possibility of altering it. A "goal" is that "orientating basis" which has to do only with reflection of the possible situation changes (future result), verbalised reflection, reflection that is connected with motive.

Within the context of the problem of goal-formation, it is important to take into account the following significant characteristics of action and activity in general:

1. *Goals and results of actions.* The anticipated result is not necessarily attained, therefore the actions are divided into the successful and unsuccessful. A successful action also produces results which have not been part of the set and attained goal (the result of an unsuccessful action is completely different from the goal). A result of action always contains something new with respect to the goal. One must distinguish at least three types of new results; the realised goal, a by-product of purposeful action, and the results of involuntary activity which are incorporated into the process of performing a purposeful action.

Transformations of objects, whether anticipated or not, are not the only results of an action that has been performed. Man's functional state alters after completion of an action, emotional responses arise, and skills are improved. All this can be regarded as "inner" results of an object-related action. These results may also correspond to the direct goal or act as a by-product of action. Anticipated results and by-products, the correlation between goals and results may have a different position in time (be either near or distant).

Singled out inside an action are not only the different types of results (direct and indirect) but also different goals (a hierarchy of goals). An action is assessed both in terms of its relation to the "ideal" goal towards which it strives and in terms of the concrete ("actual") goal to which it directly corresponds. When actual goals are changed, the ideal ones may still remain relatively stable.

The image of future result is always associated with the subject's assessment of the significance of this result and its attainability by an action.

2. *Psychic reflections of future results of action in the form of a goal.* The goal is usually described as a *representation* of the future result. However, the goal is not the only form of mental reflection of future results (just as representation is not the only form of psychic reflection). In performing such actions as copying an object or a picture or reproducing a movement, the future result is represented as a perceptual image. Often, it has the form of a verbal description, meanings conveyed through speech (concepts with a varying degree of the concrete or the abstract). Mental reflection of future results has a varying degree of clearness. This refers both to perceptual images, representations and concepts. Since a verbal description of the goal has a variety of aspects, it is necessary to distinguish between the general meaning and the operational sense of the goal, i.e., that concrete (contextual) meaning which the testee himself selects out of the multitude of possible meanings. The result of an action can be anticipated with a varying degree of certainty. For instance, the goals of trial ("let's see what comes of it") often belong to the category of uncertain anticipation. There is quantitative and qualitative certainty of goals.

3. *Goals and motives.* The distinction between goals and motives (needs) in the structure of man's activity is decisive for understanding goal-formation.

By itself, the image of a future result does not form a goal (weather forecast, awareness of the fact that everyone must die). It becomes a goal only when connected with the need-motivational sphere. Psychology has not yet made an adequate study of this sphere, specifically, the correlation between needs and motives, and this hampers a research into goal-formation. Nevertheless, some tenets can be defined.

Depending on the motives with which the goal is associated, it acquires different personalised senses. Classification of needs may be used as a foundation for a classification of the goals that may arise on the basis of these needs (gnostic, commu-

nicative). The same goal may relate differently to different motives under the conditions of polymotivated activity. When motives have different directions, goal-formation proceeds in a conflict situation. The "encounter" between the need and the object fulfilling it is not over after the formation of unrealised motives and attitudes. When motives and attitudes come up against an obstacle, this may lead to formation of goals. Among the other features of the "encounter" between the need and the object that promote the formation of goals are mastering a subject in the course of joint activity, incomplete satisfaction of the need by the subject, and the subject's relation to several needs simultaneously. Dynamic changes of the motive (saturation) are a condition of the emergence of new goals.

Awareness of the motive can have dual consequences: the emergence of motives that act as goals, with the orientation of activity remaining unchanged, and the emergence of goals that are anti-motives. The subject's activity is in the latter case directed at neutralising, or suppressing the operation of the conscious motive. In this case, new motives arise, or the hierarchy of motives undergoes an alteration. It is the hierarchical relations within the need-motivational sphere that create the opportunity for the emergence of goals directed against meaningful needs. A complex relationship exists between the need and attitude: the attitude is replaced by the goal when the operation of attitude mechanisms is not adequate; attitude determines selectivity with reference to the possible goals; attitude appears as a product of the goals' transformation (the formation of intention as a result of the decision that has been made).

4. *Goals and awareness.* Awareness of a purposeful action may be described on the basis of several parameters: awareness of the object-related result that has been attained; a conscious anticipation of the future result; additional awareness of some by-products; awareness of the relationship between the goals and the objective situation (realistic and unrealistic goals); awareness of the relationship between the goals and the needs (acceptable and unacceptable goals); awareness of the relationship between the goals and the abilities (easy and difficult); awareness of the process of goal-formation *per se*. A conscious correlation of the goals with the situation is executed not only with reference to the actually existing situation but also to the imagined, conjured situation. In cases of joint cooperative activity, and especially in the context of struggle, another person's goals become the object of realisation. Understanding of man by man includes understanding of another's goals. Consequently, in acti-

vity consciousness is represented much more extensively than merely in the form of "goal".

Let us now examine goal-formation, i.e., the process in the course of which goals arise. For simplicity's sake, we shall confine ourselves to individual activity, although the problem of goal-formation has a direct bearing on joint activity as well.

1. *Prerequisites for the emergence of new goals in individual activity.* Among them is the emergence (actualisation) of new needs and motives, assimilation of new knowledge about possible goals (results), acceptance of new requirements for an action, appearance of new results of individual actions, failure to attain the anticipated results, emergence of new unconscious anticipations of future results of an action. Analysis of goal-formation includes a study of these prerequisites and the conditions which make the transfer from prerequisites to goals possible.

2. *Transformation of the accepted requirement into a goal.* Transformation of requirements into individual goals is a widespread variant of goal-formation. An individual views a group goal as a requirement which has yet to be accepted. Moral and legal norms are a source of goals but should not be identified with them (since otherwise law-breaking could not have been explained). The issue of the socially generated and the individual goals is a particular manifestation of the more general problem of the correlation between individual and social consciousness, social and individual needs and social and individual practice. All goals have, at one time or another, been generated by individuals, but social (or group) goals are not merely a sum total of the individual ones, since not all individual goals turn into social (group) and the selection proceeds in conformity with non-individual laws. The dependence of goals of individual activity on social and historical factors is determined by the assimilation of social goals and objective social conditions (the goal "to graduate from a university" cannot arise prior to the establishment of the system of higher education), the social nature of the formation of individual needs, the mastering of language as, initially, the means of registering the attained and anticipated results of practical actions, and later as a means of performing a certain class of internal, mental actions, which too, *are* actions. Assimilation by an individual of non-individual goals (requirements) is marked by selectivity, which is determined, among other things, by personal experience.

3. *Selection of one of the requirements.* Social experience is controversial, and that is why a person is often confronted

with contradictory requirements (one of the commonest cases is the mother, the father and the grandmother expecting different things from a child). On this basis, differing, and sometimes incompatible goals are formed. In the simplest cases, these may be contradictory instructions in performing elementary object-related actions, and in the more complex, a conflict of moral principles. Selectivity is more pronounced when assimilating goals (requirements) than in assimilating methods of intellectual activity and concepts. A research into personality development has made it possible to single out the following conditions, which determine whether the subject accepts the requirements as the foundation for goal-formation: a link with an actual need, a link with a potential need, the goal as a means of resolving a conflict between two opposite needs (the goal's motivating force is engendered, in this case, by both these needs). Requirements are not necessarily contradictory, they may differ only in the degree of complexity. Precisely this pattern emerged from well-known experiments aimed at studying the level of aspirations (a particular case of goal-formation). It has been shown that goals are formed only on the basis of tasks situated within a certain zone of complexity.

Assimilating social experience, man also acquires certain individual experience. This applies both to the assimilation of requirements which give rise to individual goals (the formation of an individual conception of the goal and of an attitude to it), to the process during which a goal is attained (application of the content that has been assimilated), and to the process of reconstruction that occurs when previously assimilated goals stored in memory are reproduced, and the transformation of social experience that has been assimilated.

4. *Voluntary and involuntary goal-formation.* In cases of independent goal-formation, i.e., when a goal directly formulated by someone else is absent, one should distinguish between voluntarily and involuntarily unfolding processes. An instance of involuntary goal-formation is the emergence of gnostic goals in a problem situation. Creation of goals for other people under the conditions of joint activity is an example of voluntary goal-formation. Involuntary goal-formation is associated with an independent transition from involuntary to voluntary processes, while voluntary goal-formation means differentiation between at least two levels in the functioning of voluntary processes themselves. One level is connected with subordinating the processes to a certain task (goal), and it is this level that is described in

textbooks when voluntary movements, voluntary attention and voluntary memory are characterised. The second level is associated with a conscious selection and formation of the tasks proper, with the creation of hierarchy of tasks. The goals are, as it were, doubled: the goal of generating goals arises.

Involuntary goal-formation is a process. A goal may also be a product of independent actions, as in the case of voluntary goal-formation. Goal-formation becomes independent activity when the task of generating goals is linked with an independent motive (as is known, the theory of activity regards the presence of an independent motive as an organic property of activity). Consequently, goal-formation exists in three forms: as a process, as an action, and as activity. The latter form is the most pronounced in communication, when besides setting the other person goals produced by the needs of joint activity, certain conditions may engender another goal, that of forcing one's goals upon others (the wish to assert oneself, to demonstrate "firmness of character", "will power"). An even higher level of voluntary goal-formation is connected with the intention to disguise the real goals and present false goals. A number of devices used in goal-formation can be singled out: the development of gnostic processes involved in comprehending the situation (placing it in a definite category), postponement of the final decision, provisional acceptance of the goal, drawing lots, asking for advice.

5. *Temporal dynamics of goal-formation.* Viewed as a process, an action may be said to have three component parts: the formation of the goal, progress evaluation, and evaluation of the final result. Goal-formation itself may be a process that unfolds in time. A distinction is made between preliminary and final goal-setting, and the two do not necessarily coincide. A significant indication of temporal dynamics are the changes in the subsequent goals depending on the results and goals of earlier actions. The temporal characteristics of a consecutive goal-forming process are supplemented with hierarchical relations existing between a multitude of goals. When the anticipated results have not been attained, the goal is changed.

Distinguishing actual and ideal goals makes goal-formation more complex: new ideal and new actual goals emerge, and new relations between the two groups are established. F. Hoppe noted that, with the attainment of the ideal goal, a *new* ideal goal appears which goes beyond the bounds of the given type of activity (self-level as distinct from the level of aspirations). Thus, the dual nature of the tendency in forming actual goals (the level

of aspirations): to attain success at the highest level possible, and to avoid failures.

A person not only appraises the achieved results as success or failure but also forecasts the success or failure of an action. It is because the goal of an individual action is correlated with the more general self-level (self-appraisal), the feelings of success or failure arise only inside the zone of the subject's potentialities. When a sequence of goals is formed, each is compared against previous results and previous goals.

6. *Standard and original goals.* Another distinction to be made is between standard and original goals (one can hardly consider the goal "to have a drink of water" as original). This distinction makes it necessary to specify the parameter formulated as the productivity of actions: the product obtained by realising standard goals (e.g., making a machine part according to an established technology), and the product obtained by realising an original goal. In the latter case, an action is, as it were, doubly productive: the creation of a new material product is preceded by the creation of a new ideal product. New results may sometimes be achieved both when repeatedly implementing already attained goals, and when attaining assimilated standard goals, as the new object of activity and/or new methods and instruments of activity also make a contribution.

6. *Psychological mechanisms of goal-formation.* Apart from the examined mechanisms, others can be distinguished, including a) transformation of motives into goal motives in the process of gaining an awareness of them; b) transformation of side-effects of action into a goal through a connection with the motive and gaining awareness of the result; c) transformation of unrealised results into realised; d) establishment of intermediate goals triggered by obstacles, joint practical activity, correlation of the object with several needs, partial satisfaction of the need by its object. Let us now look at experimental research into goal-formation.

§ 2. Motives and Goal-Formation

One of the approaches to studying motivation is to analyse their vital role in man's activity, their functions. The most clearly pronounced is the *inducing function*: movement towards the object which represents a certain need, or, vice versa, avoidance of the object in case of negative motivation. Another function is the *sense-forming* one. Actions are not only performed, events are not only perceived, but also assessed by the subject

with reference to the motives in the form of personalised senses. The distinction between these functions has formed the foundation for one of the classifications of motives, that which divides them into directly inducing and sense-forming ones. If one is to consider the relationship between motive and goal, i.e., the correlation between the two basic components in the overall pattern of the structure of activity, the presence of motive will be a condition of attaining the goal. Personalised sense is a form of presenting the subject with the goal itself and the process of its attainment. In both cases, the "goal" functions as a complete, already formed entity.

Research into the processes of goal-formation makes it necessary to further analyse the complex relationships between the goals and the motives of man's activity, gaining more knowledge about the functions performed by motives. A hypothesis has been advanced which maintains that motives also have a *structural function*. To substantiate it, experimental research has been carried out which will be described later. It has been made on the basis of using the material of thought activity viewed as a unity and interaction of processes of sense- and goal-formation. Besides the final goal, a major role in man's activity belongs to intermediate goals, which are formed independently and which are defined on the basis of the task's conditions. At the same time, intermediate goals prove relatively independent, they are linked to the final goal and reflect some of its essential characteristics. This has determined the basic idea and purpose of the research: varying motivation, tracing the structure of the processes involved in forming intermediate goals when solving intellectual tasks.

The methodology. Research has made use of two types of situations: dealing with a problem proceeding from the experimenter's "neutral" instructions, and "intelligence testing", a situation which has provided the conditions for forming motivation of the "prestigious" type (intelligence testing has not been the real purpose). In conformity with these two situations, two series of experiments have been staged. To study the emergence of intermediate goals and the process of transition of unverbalised anticipations into verbally expressed goals, *the method of comprehensive registration of the testees' eye movements and verbal activity* was used. The eye movements were registered by means of an electromagnetic transducer attached to a contact lense and recorded on tape. The material was processed after the experiment, and the final chart of eye movements was registered by the PDS-21 potentiometer, with the sheets changed

every 10 seconds. Verbal reasoning was tape-recorded. Ten testees took part in the experiment, with six solving the "three squares" and four, the "four squares" problem. A feature of these problems was that they were presented visually, as a picture, and that the testee could make known situation changes by naming the numbers of the elements. The testees were requested to sustain a running commentary on their reasoning and to voice all their thoughts; their reasoning was correlated to eye movements. The instructions on the "three squares" problem stated: "To remove four sticks so that three squares remain" (Fig. 9); on the "four squares" problem, "Transfer three sticks so that four squares remain" (Fig. 10). Both problems involved moving through two phases; intermediate goals had to be formed which differed depending on the problem.

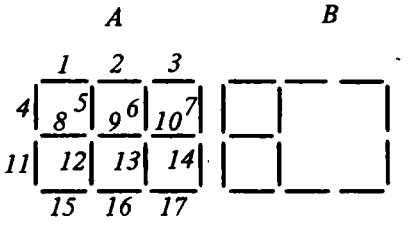


Fig. 9. A task used in the study of goal formation

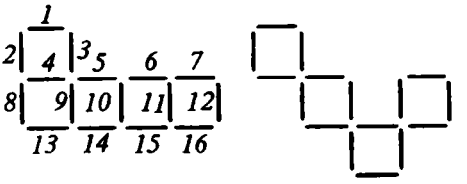


Fig. 10. A task used in the experiments. For explanation see text

The method of simultaneous registration of the process of problem-solving makes it possible to study the emergence of intermediate goals, i.e., interaction of unverbalised anticipations provisionally termed "pre-goals" with verbally formulated goals. Incorporating the decision in the various motivational structures has helped to discover which *structural* changes occur in thought activity under the impact of differences in motivation: in the system of intermediate goals, in the correlation between different types of activity, in the relationships between the general and the intermediate goals advanced at the various stages of problem-solving. The experimental material was analysed for a number of parameters. Distinguished in examining verbal activity were verbally formulated intermediate goals, the testees' verbal assessments of these goals when contrasting them against the general goal, and repeated returns to once discarded intermediate goals. Recorded in analysing non-verbal activity was the time and number of registrations of elements making up an intermediate goal, the distribution of registrations in the process of problem-solving, the number of lengthy registrations, the number of elements that have been examined by repeated eye movements, the eye's "work" with elements that have been included into inter-

mediate goals, the number of registrations of elements making up those intermediate goals which lead to the solution, the first visual tracing of these intermediate goals and the number of such tracings throughout the time of the solution. A comparison of the indicators characterising the testee's verbal and non-verbal activity makes it possible to answer the question concerning the correlation between the two levels of the task's analysis, and the volume of work necessary for the transition of unverbalised anticipations into verbalised intermediate goals.

Results and their discussion. Experiments have shown that in the course of their activity, the testees set intermediate goals with a view to reaching the general goal. Intermediate goals arise at the various stages of problem-solving and play a subordinate role with respect to the general goal. The latter regulates the process of setting intermediate goals although, at a certain stage of the search for solution, an intermediate goal is important in its own right. The general goal regulates the analysis of the conditions under which it has been set. To a large degree, these processes unfold at the unverbalised level, but some of their results may be given a verbal form. In solving the "four squares" problem, there was a difference between the series in the number of verbally formulated intermediate goals: in the situation of "intelligence testing" (second series), twice as many were named. In that situation, nearly all elements were reflected in the verbal record, and more than once: from two to six per element, whereas in the first series no element was named more than twice. A tendency towards extended verbal reflection of the problem-solving process and formulating intermediate goals is one of the substantial distinctions of problem-solving in the situations with a more or less significant motivation. As a consequence of a higher degree of verbalisation of the problem-solving process, the number of independent correct assessments of the intermediate goals advanced at a given stage increases. In the first series, the experimenter had sometimes to help the testee to see the unsoundness of a certain intermediate goal with reference to the general goal. The parameter of verbal evaluations is important also as an indicator of the testees' critical attitude to the results of their activity. In the situation of "intelligence testing", the testees gave independent evaluations of 80 per cent of verbally formulated intermediate goals, while in solving a problem in accordance with an instruction, this was only 50 per cent.

Consequently, as the importance of the result increases (the testees taking part in the second series were promised an evaluation of their activity), the testees show a more critical attitude to

the results of their activity and a tendency towards a timely correlation of the outcome of the transformations they have performed with the result that ought to be achieved. Essentially, the intermediate goals formulated by the testees may be divided into three groups. The first covers general goals, i.e., those that determine the direction of the search and may affect the definition of subsequent goals but do not include analysis of individual elements. For instance, testee No. 5 (second series) advanced the following idea: "One should probably manipulate with the sticks that are on the outside of the figure—if you touch the inside ones, you'll have to pick up too many sticks, three sticks won't be enough." In accordance with this general idea, he later formulated more concrete intermediate goals. The second group is made up of concretely defined intermediate goals, with all the elements taking part in the transformations named, and their moves pointed out. For instance, testee No. 4 (first series) said: "The sixth element can be moved higher up, to continue the first, the fifteenth could continue the tenth, and the eleventh and the fifteenth could change places." The third group includes incomplete, i.e., not fully formulated intermediate goals, with the testee moving a smaller number of elements than has been stipulated by conditions set by the tasks or failing to complete the transformation. The intermediate goals within these three groups are represented in the testees' activities in a variety of ways, depending on the situation in which problem-solving takes place. All three types are most fully represented in the series of experiments aimed at "intelligence testing". The most striking differences occurred in the concretely defined intermediate goals group, with the number of these goals named in the second series exceeding that in the first by 50 per cent, and in the incompletely formulated goals group, where it was increased 200 per cent.

The desire to check one's moves, to consider the mutual position of elements in the figure and the consequences of a move, was clearly observed in the actions of the testees involved in the second series of experiments. This strategy left an imprint on another parameter, the time taken by the testees to find the solution, which in the second series increased, especially in solving the simpler problem, "the three squares". This tendency is observed not only at the verbal but also at the non-verbal level. In the second series, where the motivation was more significant, the testees tended to analyse nearly all elements of the figure as carefully as possible, and to rehearse the possible transformations. Both the analysis of the elements and the rehearsal of transformations were performed repeatedly.

Research necessitated singling out sets of transformations, e.g., tracing the intermediate goals leading to the solution. All testees had engaged in this work long before verbalisation, and repeated their actions. Thus, testee No. 4 (the first series) made three tracings, although they proved insufficient for finding the solution, which was not verbalised. Judging from his eye movements, testee No. 5 (first series) made the first tracing between the 41st and 50th seconds, and then performed eight more tracings. The solution was verbally formulated between 490th and 510th seconds. The first visual tracing of the solution was made by testee No. 5 (second series) between the 51st and 60th seconds, and was repeated 24 times during problem-solving, verbalisation occurred between the 846th and 855th seconds. This testee needed a greater amount of unverbalised work to find the solution.

We see that the situation of "intelligence testing" included a prolonged stage of preparations for the definition of intermediate goals through visual analysis of the situation, which was reflected in the longer eye work with the elements making up intermediate goals, larger number of repeatedly examined elements, repeated rehearsals of individual transformations of the existing situation, and tracings of intermediate goals leading to the solution. This strategy was applied during the solution of both problems in the situation marked by more significant motivation. In dealing with the simpler problem, "the three squares", the testees traced the solution from two to 13 times before giving it a verbal form. The testees taking part in the "intelligence testing" took three times as much time to solve the same problems as the testees solving the tasks in conformity with the instructions. In the situation with less significant motivation, the testees made fewer movements and did not display the desire to double-check their actions; however, all coped successfully with the problem. Consequently, in the situation of "intelligence testing" the stage of preparing verbal definitions of intermediate goals through unverbalised activity increased, although in dealing with simple tasks this may not be clearly observable. The transition to the intermediate goal takes more time than when a problem is solved in accordance with an instruction.

In dealing with visually presented tasks, the transformations are performed at two levels: at the level of visual analysis of the situation, when they may assume the form of unverbalised pre-goals, and the level of verbal discourse, which may be described as a system of intermediate goals expressed in a verbalised form. These levels enter into a variety of interactions. The first type is

"precedence", at which visual work with individual elements pertaining to an intermediate goal precedes its verbal formulation. The intermediate goal is formulated after certain preparatory work, as a result of the establishment of interrelations between the figures' elements and deliberations concerning the possible transformations. This type of relations prevails in both series. More than a half of the cases are in this category. However, the number of "precedences" in the second series is 150 per cent greater than in the first. The second type is termed "coincidences" and embraces the cases when the work with the elements constituting an intermediate goal is simultaneously performed at both unverbalised and verbalised levels within the same ten-second interval. The number of coincidences in the second series is more than 200 per cent higher than in the first. The third type has been termed "delays". In this case, a verbal definition of the intermediate goal is made earlier than the eye work with the elements pertaining to it. It is likely that the main unverbalised work with individual elements was performed several dozens of seconds earlier. The structure of visual search changes under the influence of verbally formulated intermediate goals. The situation with less significant motivation displayed a larger number of such relationships than that with more significant motivation. While in the first series the proportion of delays was 25 per cent, in the second it was only six per cent.

The basis of the interaction between verbalised and unverbalised components in the process of forming intermediate goals is the constant change in their functions. Some of the results of actions executed at one level become regulatory factors of subsequent actions performed at another level. Depending on the type of motivation prevailing in the situation into which problem-solving is included, the mutual relation of the two levels of activity changes: in formulating intermediate goals in the situation marked by more significant motivation, a greater amount of preparatory unverbalised work, or simultaneous analysis of the transformation of the existing situation at the two levels is required. While in the first series verbalised definitions are mostly those of individual intermediate goals, in the second series there is also a tendency to make *generalisations* and *evaluate* the results of activity, the possibility or impossibility of attaining the intermediate goal. The situation with less significant motivation demonstrates a larger degree of convertibility of verbalised and unverbalised components: a verbally formulated intermediate goal more frequently acts as a regulator of unverbalised work than in a situation with more significant motivation.

Work with the elements composing the intermediate goals begins long before it is verbalised. Testee No. 5 (first series), who was tackling the "four squares" problem, began work with the elements 4, 8 and 13, which were incorporated into one of the intermediate goals, starting with the 30th second of problem-solving, while its verbal definition took place between the 210th and 240th seconds. The largest number of registrations of these elements were made within the intervals preceding and following the formulation of the intermediate goal, when the result of the figure's transformation was checked once more against the problem conditions and the correspondence between the results of the transformation and the general goal were tested. The testing represents the results as either satisfactory or not; the testees involved in the second series did the testing and evaluated the results mostly on their own initiative, while in the first series, the examiner's suggestion was required.

Clearly, the strength of motivation prevailing in a given situation makes an impact on such structural component of thought activity as intermediate goals and their formation.

Conclusions. Research that has been undertaken has confirmed the hypothesis maintaining that, together with the traditionally identified functions (those of inducing and the sense-forming), a motive also has a structuring function. A systematic analysis of goal formation has made it clear that this function makes itself felt a) in the productivity of the process of intermediate goal-formation; b) in the strategy of unverbalised search (which is marked by thoroughness, repeated examination of elements and their possible relationships, rehearsal of the variants of the transformations of the existing situations, an optimal number of examinations necessary to establish the relationships between elements); c) in the degree of the problem-solving process's verbalisation (verbalisation of the task's elements, of anticipations and evaluations); d) in the strength of the testee's critical attitude towards intermediate results of his activity formed on the basis of their correlation with the general goal; e) in the nature of the process during which intermediate goals are generated, i.e., the process of emergence of unverbalised anticipations and their transfer to the verbal level. We see that motive determines the scope of the testees' verbalised and unverbalised activity, the correlation between these two levels, the distinctiveness of the new entities, the intermediate goals, and the way these are generated.

Specifying the problem's requirements and voluntary goal-formation in situations with varying degree motivation.

The testees taking part in a special series of experiments were given a creative problem which made possible a number of solutions, and a deliberately vague instruction which did not specify the number of solutions that had to be found (for instance, "make up any rectangles"). This gave the testees an opportunity to set additional goals in the course of specifying the requirement formulated by the experimenter. Suggestions were also used, giving the testees an instruction which necessitated finding original solutions.

Introduction of qualitatively new motivation affects the process of evolving new goals. Depending on the actualised motivational structures, the testees either set or did not set themselves additional goals that were not directly mentioned in the instruction: "to find as many solutions as possible", "to find all possible solutions" (i.e., quantitative goal specifications). In the long run, this determines the productivity of the search. In passing from the neutral instructions to "intelligence testing", productivity rose up to 250 per cent. These data show that terminal productivity of an activity rests on the productivity of the goal-formation process. The qualitative characteristics of the final results also depend on the situation in which goal-formation takes place. In the situation when motivation was highly significant, the testees, proceeding from an undetermined requirement, set themselves the goal of "finding more interesting solutions" and sought to attain it. This somewhat weakened the influence of the instruction which required an original solution. An assessment of flexibility, which pointed to the diversity of uses made of the ideas in forming the solution, rose by 200 per cent, and the indicator of the solution's originality, by 300 per cent. Such changes occurred regardless of whether the instruction required originality or not. This fact shows that given strong motivation, the influence of the instruction requiring originality was weakened. Motives may also enhance the operation of suggestions. The more diversified the problem's structure, the greater the role of motivation, which directs the processes involved in the use of previous experience, the assessment of the significance of the situation's elements and properties, specification of the general goals and identification of intermediate ones. When a person independently sets additional goals with reference to the number of solutions and their features under the impact of significant motives, this serves as a mechanism raising the productivity of the tasks' final solutions, the quality of these solutions, and the standard of their creativity.

Another issue under examination was the influence of moti-

vation on the process of voluntary goal-formation, i.e., when the testee had to generate goals (produce the goals of changing the figure, achieving new positions of elements in the figure presented to the testee). It turns out that motivation substantially affects the quantitative and qualitative characteristics of the goal-formation process. In "intelligence testing", the productivity of goal-formation could rise by 50 per cent as compared with the action in accordance with a neutral instruction. The number of original goals (evolved by only one testee) grew by 100 per cent. The content of the generated goals changed, demonstrating an increase in the number of goals formed through actualisation of semantic content. Motivation acted as a mechanism regulating the semantic categories used in the process of goal-formation, as a factor determining the ability to see unexpected and unusual combinations of elements. In the situation with more significant motivation, the goals are more diverse (each new goal is formed with the previous one changing substantially). The ways of changing the original figure and creating new ones are more complex, original and varied in the situation with stronger motivation. They are based on a higher level of situation analysis, on discovering the in-depth links within its structure. Incomplete and unclearly defined goals (definitions of final goals without pointing out intermediate ones or the terminal situations) are set more often. An increase in the motivation strength may remove the restrictions imposed by previous experience, thus expanding the area of meanings and images used in forming the goals (to reduce the influence of "orientation"); in the long run, this produces an increase in the number of generated goals, as well as their greater diversity.

We can see, therefore, that motivation acts as a factor determining the structure of the goal-formation processes, which has made it possible to distinguish another function of the motive, the structuring.

§ 3. Emotions and Goal-Formation

A study of thinking as a process of self-development necessarily poses the question of the emotional components of goal-formation. It has been discovered that a condition of the emergence of intellectual emotions is the development of unverbalised operational senses, which also are subjected to the regulatory influence of goals. In this respect, it has become essential to analyse the influence of the type of goal-formation on emotional regulation of thinking. It has been noted that a feature of

a problem's structure is how clearly its requirements are defined. For example, in a two-mover chess problem the requirement may be formulated as follows: "checkmate in two moves". However, this position also makes it possible to set the task "to find the best move for white", or "to decide who has an advantage with white making the first move". The unspecified character of the requirement stimulates the development of goal-formation in the form of making this requirement more definite (for instance, "something must be done", "I must use the position of the black king", "I must look for a way to win", "I've got to look for a quick mate", "let's look for a checkmate").

Experiments have revealed a regular connection between emotional processes and the formation of both the final and the intermediate goals. In working on a problem whose requirements have not been specified, the number of links between intellectual emotions and the components of the goal-forming process proper increases, whereas the number of cases when a link between intellectual emotions and the results of attempts is observed is reduced. Formulating the goal on the basis of the definition of requirements passes a number of stages in which it is made more specific. The periods of specification are prepared by the development of the situation's reflection, which is performed both in the course of the situation's examination and re-examination, and in making research attempts. The process of specifying the goal is affected also by the testee's level of aspirations in a given sphere of thought activity, as well as the complexity of the goals that have been formed. Intermediate goals are formed on the basis of the final one but not directly. This process is mediated by the mental reflection of the situation, in which hindrances in the way of attaining the final goal (first secondary and then primary) are distinguished above all.

Goal-formation has two mutually dependent and interacting aspects, the cognitive and the emotional. Besides changing the verbal definition of a goal on the basis of the set requirement, personalised sense of the goal is formed which expresses its relation to the motives of thought activity. Experimental research indicates that the arising intellectual emotions are a necessary component of this process. They perform the function of an internal signalling system pointing to the formation of the sense of the final goal at individual stages of the work to attain it. Intellectual emotions are a signal that the final goal that has been accepted corresponds to the motives (above all, cognitive ones) of thought activity. We see therefore that an act of accepting a requirement as one's own goal has a complex psycho-

logical structure, incorporating phases of implementing it that are separated in time, and are marked by the degree of definiteness (the degree of the goal's acceptance).

Emotions precede and prepare the verbal forms assumed by the final goal, and its ultimate definition. The very content of the formulated final goal determines the orientation of intellectual emotions towards certain actions and operational meanings. Testees involved in one of the experiments were asked to solve the same problem. They took different amounts of time. The quicker solution was regarded as the more efficient one. It has been discovered that prevailing in the more efficient process as compared to the less efficient one, were the links between emotions and the formation of sub-goals and the emergence of unverbalised ideas. Vice versa, dominating the less efficient process were the links between emotions and the results of attempts, with the bulk falling to the ties between the emotion of failure and negative results of attempts. It has also been revealed that the more efficient process is more emotionally loaded. This prevalence could be traced in all situations, but most clearly at the stage of the initial examination of the situation and beginning of efforts at solution.

A major trend in the study of goal-formation is the analysis of the primary initiation of thought activity, the transition from non-thought to thought activity. Soviet researcher V. Klochko has developed original methods which have made it possible to study the role of emotional assessments in this process. One of the methods he employed is described below. The testees were given a specially compiled text which contained a disguised contradiction that could form a basis for defining a physics problem. The text was described as an excerpt from a work of fiction called *The Gold-Diggers,* and a fictitious author was named. Here is the text:

"The boat was immediately caught up by the flood. The river was carrying it as if neither the boat nor the passengers had oars or any other means of resisting this all-powerful torrent. During sharp drops, to the frightened travellers the shores seemed to move with horrifying speed. The boulders at the shores and the rare trees flicked by in a varicoloured belt which made their heads spin. When going up, the current became slower, it seemed to subside, to grow darker. The river was like a living being, it ran downhill with joy and ease and became lazy, unrecognisable on the rare but long and high climbs, like a traveller carrying a heavy load uphill. The boys would pull themselves together and exchange dumb looks, but, before they had time to

laugh at their frightened faces, the flood would again crash down from the conquered height and the rapid flickering and the agonising wait for the next respite would begin again."

The text did not arouse any doubt on the part of the testees as to its authenticity, although three times it mentioned facts which went against the experience and knowledge that they had received either at secondary school or higher educational establishments. The experiment involved 45 testees (high school pupils, students of a physics department, and teachers). The testee was given the text, and instructed to *check it for grammatical mistakes.* He was also told the presumed purpose of the experiment: to test the testee's spelling ability. After the testee pointed out the spelling and punctuation mistakes he had noticed or reported their absence, the text was taken away, and the testee was asked to retell it in as much detail as possible. The structure of the experiment was designed to reveal whether the testee had noticed the contradiction, which had to be done unostentatiously, without asking any direct questions, since otherwise the testee might have developed an attitude in respect to looking for the contradiction, and this would have hindered the experiment. The method was based on the application of the basic law of involuntary memorising, according to which a person tends to memorise that material which corresponds to the goal of activity. If the testee noticed the contradiction and performed a certain amount of activity to grasp, define and remove it, the material connected with the contradiction (which, of course, was the main point of interest for the experimenter) should have been retained in involuntary memory and brought up at the subsequent reproduction. If the experimenter observed that the contradiction had remained unnoticed, the experiment proceeded. A second requirement was advanced: *to memorise the text* after reading it once. The testee was told that another presumed purpose of the experiment was to test his mnemonic abilities. The testee read the text once without interruption, and tried to recapitulate its content as closely as possible. If he continued to be unaware of the contradiction, the experimenter asked him whether he had noticed any contradiction or discrepancy, or whether something seemed strange and incongruous. If the contradiction still remained undetected, the experimenter passed on to the third stage. The testee was asked *to find a contradiction* in the text. He was requested to read the text and to reason out loud. The galvanic skin response was measured throughout the experiment.

The second method was a modification of that which was used by Nikolai Eliava (the testee was to guess which word was im-

plied by the examiner, e.g., "c—wn" could be read as either "clown" or "crown"). The modification consisted in continuously recording the oral discourse, the GSR and the ECG.

The third method was as follows. The testees were shown pictures, and, under the pretext of testing how observant they were, asked to give the most detailed account of what they had seen. All in all, thirty pictures were shown, which were arranged in groups of three, linked up by a common idea. The pictures were presented in sequences. Shown the first picture, the testees had to describe what was in it, after which the second picture appeared, with the first one also remaining visible. The story based on the second picture was followed by the third picture, which also had to be described. Some of the groups contained contradicting representations, which could be detected only in relating the pictures in the group to each other. For example, the first picture could represent a ball on the edge of a hole. The second picture showed the ball rolling down into the hole. The catch holding the ball in place was raised. The third picture showed the ball jump out of the hole and roll up higher than the original level. The contradiction does not arise if the last two pictures are not viewed together. If all the pictures are considered from the angle of their mutual relationship, the contradiction may be discovered: the ball cannot rise higher than its original position, for this would signify a violation of the law of the conservation of energy. A question arises, and a physics problem emerges: under what conditions could the depicted action actually take place? Hypotheses are advanced, including suppositions concerning the added speed, non-potential field, a magnet fixed at the other slope. Reproductive activity—a story on the basis of the picture—is replaced by thought activity. The testee's discourse and his GSR were tape-recorded. In processing the results of the experiment, primary attention was given to the analysis of the points where cognitive contradictions emerged and were formulated : "something is wrong", "that just can't happen", "this is impossible unless...".

The results of research using the first method. It has been discovered that the chances of finding the cognitive contradiction changed according to the type of activity involving the same material. In dealing with the task in accordance with the first and the second instructions the contradiction was detected by only three out of 45 testees, in accordance with the third—35. Consequently, detection probability cannot be inferred from the abstract ability "to see the problem". In carrying out the first instruction (to check the text for mistakes) the testees were so

absorbed in this activity that the meaning of not only individual sentences but of the text at large was not really grasped. The testee's various types of activity involving the same material offer differing *opportunities* for discovering the contradiction and, consequently, the problem, which is, as it were, concealed in the material. Activity and the condition under which it proceeds set diverse demands with respect to the correlation of the incoming and the available knowledge. The greater the need for the correlation of meanings with their object-related sensual foundation, the greater the probability of finding cognitive contradictions, which may form the basis of the emerging mental goals. Evaluations accompany the process of correlating the available (present in the subject's experience) and the incoming knowledge checking the accuracy of his ideas (knowledge) concerning the world. They also act as components of the mechanism representing the need to introduce corrections in the subject's own knowledge in order to adequately reflect the world, or corrections in the object world in conformity with the subject's knowledge. Analysis of the cases in which emotional assessments were formed in the course of activity which was not aimed directly at finding the contradiction (the first and the second instruction), indicates that many testees "avoided" the conflict segments by dropping the conflict content from the material they were reproducing, or transforming it into neutral content even at the cost of distorting the meaning of the text or introducing new notions cancelling the conflict. The contradiction *per se* was not realised by the testees as it actually was, but some stated: "There was something", "I sensed something strange", "Something was wrong". However, the testees mentioned these sensations only following the experimenter's question about the presence or absence of contradictions in the text.

The experimenter formed a group out of the testees who avoided the conflict parts by making their content neutral or omitting them altogether (28 persons). The rest, 14 people, formed the second group. In telling the story after having fulfilled the second instruction, they included the conflict points, but remained unaware of the contradiction. It was revealed that success in looking for the contradiction in conformity with the third instruction (purposeful search for a contradiction), depended on how the contradictory information was presented after fulfilling the second instruction. Among the seven people who failed to discover the contradiction in acting on the third instruction, not a single one had "avoided" the conflict at the previous stage of work. All seven testees included the description of the

conflict parts without discovering the conflict itself. The 28 testees who had "avoided" the conflict parts in reproducing the text discovered the contradiction after receiving the third instruction. The very fact that they had avoided the conflict, or changed its content, shows that they actually reacted to the contradiction even if they were not aware of it. This unconscious level of reflecting the contradiction paves the way for a purposeful, conscious and successful search. This conclusion is confirmed by the fact that all testees who had reacted to the contradiction at the unconscious level subsequently managed to discover it in the process of purposeful search. All in all, six testees mentioned "something strange", although they were unable to say exactly where the sensation came from. One of the testees said it was the description of the river: "A strange river. The boys were sailing for a short while, and the speed of the current changed so quickly." It is very interesting that one of the testees stated that he would be able to find the contradiction if allowed to have another look at the text: "I more or less remember the place where I sensed that something was wrong! But I didn't understand just what it was."

Analysis of the GSR recordings revealed that in all six cases, skin resistance rose at the time of going through the conflict parts. Similar changes in the GSR were recorded in those 12 cases when the testees did not register "this vague feeling" but distorted the text to avoid the conflict. The growth of skin resistance was associated with the pending transformation of activity, the transition to thought activity, which necessitated a stop, a termination of meaningful activity. Experimental research has made it possible to identify the following levels of the testees' response to the contradiction:

1. No mention was made of a contradiction, and no efforts undertaken to avoid or transform the conflict parts in reproducing the text. The GSR of these testees reveals both ups and downs which are not directly conditioned by going through controversial phrases.

2. No mention was made of the contradiction. The response to it was indirect and manifested itself obliquely through attempts to distort the information, represent it as devoid of conflict, or circumvent it. In eight cases, a significant increase in skin resistance was recorded.

3. A feeling of discrepancy followed the reading of the text ("something was wrong"), with the actual cause of the incongruity remaining unidentified and unlocalised. An increase in skin resistance was recorded coincidental with reading through the conflict parts.

4. Becoming aware of the contradiction after reading the text in response to the experimenter's question. A sharp increase in skin resistance was recorded, which remained unchanged until completion of the reading.

5. Becoming aware of the contradiction while reading the text. This was the case with just one testee. Skin resistance increased sharply for 15 seconds in reading the conflict part. The testee continued reading, but his goal changed: instead of memorising the text, he tried to discover the cause of the discrepancy, selectively using the incoming knowledge to comprehend the conflict. Within 15 seconds, he managed to grasp the contradiction. The unfolding of the process is typical: the first of the three conflict parts provoked only a very insignificant increase in skin resistance, the second produced a sharp increase, and the third was accompanied by a still more dramatic increase. After 2.5 seconds, there was a drop, which probably occurred because the testee had understood the contradiction. These levels of response to the contradiction reflect the stages of forming a gnostic goal.

In the case of testees who, in working to fulfil the second instruction sensed the contradiction but did not discover just what it was, the purposeful search for conflict unfolded in a different manner as compared to the testees who had not noticed any contradiction at all. The text was read through, the reading being interrupted only in conflict places. In all cases, the discovery of the contradiction was preceded by an increase in skin resistance, which was followed by a drop when the contradiction was verbally expressed. In one case, the increase stopped about a second before the testee reached the critical passage, the reading of which was accompanied by a sharp drop in skin resistance. The analysis of recordings has made it possible to conclude that the emotional hue acquired by elements of the text at the first reading (operational emotional memory) provided the pointers indicating the location of the contradiction. These were used by the testee during the purposeful search for it. Emotional assessment marks the zone of contradictory elements where the concrete contradiction is to be sought. The tempo of the reading in acting on the instruction "to memorise the passage" and during the search for the contradiction did not really differ in the case of some of the testees, but in the second case the reading was interrupted by the testee voicing his hypotheses concerning the possible contradiction. This fact confirms that not all elements are examined for contradictory content. A pause in the reading occurs simultaneously with the signal warning the person of the

approach of a "suspicious" element. At one point, after identifying a critical passage, a testee analysed it up to seven times but failed to completely uncover the contradiction itself, deviating from it to the features which were only its consequences. A barrier probably exists between the emotional assessment of the contradiction and its verbalisation, to overcome which, considerable effort (not always successful) is required.

Results of research carried out under N. Eliava's modified method. The experimenter analysed 24 cases when the reading was interrupted because the testees found it difficult, or failed, to fill in the gaps to produce a coherent sentence. Reproductive activity (reading) was transformed into search activity. Pauses occurring because the testee shifted to a new goal (looking for the word's meaning), were accompanied by an increase in skin resistance following the pause after an insignificant (1-3 seconds) latent interval. The rise lasted only until the moment when the testee was ready to resume the reading. Different types of returns to earlier activity were observed: either the testee managed to find the word, or refused to continue looking for it, or, after the testee's unsuccessful attempts, the experimenter gave him permission to continue reading. Vivid emotional states arose during the pauses, which manifested themselves in changes in intonation and facial expression, and that made it possible to compare them to similar manifestations of successful activity and the corresponding GSR and ECG indicators.

In this series of experiments, the contradiction (absurdity) was engendered by the dissonance between attitude and the context. It some cases, discovering the contradiction meant that the testee had to restructure his activity, which allowed a return to the initial situation and produced attempts to change, transform the activity that had failed to produce the desired result (had been locked up in the contradiction). It other cases, the contradiction has an external meaning with respect to the activity, and then the testee either tried to eliminate the contradiction from the very material he was dealing with and not change his mode of action, or did not attempt to change anything at all marvelling at the absurdity as something that was beyond the boundaries of his activity and was not connected with it. Preceding the formation of a verbal assessment and the discovery of the contradiction's logical structure, was the stage of emotional assessment pointing at the presence of a contradiction ("something is wrong"). It this case, emotional assessment took place against the background of increasing skin resistance connected, probably, both with the emotional colouring acquired by some

of the elements and the slowing down of meaningful activity manifested in the change of the tempo of reading. Surprise, the discovered ignorance, failure to understand, may be external with respect to the activity and make no impact on its content and direction, i.e., not lead to the emergence of a special cognitive goal whose attainment removes lack of understanding and ignorance. Should this be otherwise, any instance of absence of knowledge would have produced a problem situation.

The following data pertaining to gnostic goal-formation were obtained.

1. Against the tonic changes of the GSR, vividly manifested emotional states emerge which are associated with a negative estimate of a given part of activity ("No, I can't fill in the gaps", "Oh, I can't", "I've no idea of this") and ultimately compel the testee to give up trying to find the meaning of the word.

2. The increase in skin resistance shown by the GSR curve precedes the emergence of questions which lead to a transformation of reproductive activity into search activity.

3. Negative assessments of activity may begin interacting with the general motive of activity which, in some cases, may compel the testee to refuse to further participate in the experiment ("Enough! I don't want to go on!").

4. The discovery of discrepancies (absurdities, and incongruities) does not immediately lead to perception of the problem. The contradiction may not be represented at the verbal level but remain at the level of emotional assessment in the form of emotional colouring of certain elements and a sense of dissonance associated with it ("I seemed to sense something but was not aware of just what it was").

5. Neither does realisation of the contradiction (verbalisation) mean that perception of the task has taken place. For a gnostic goal to arise, it is necessary for the dissonance represented (reflected) at the emotional and verbal levels to acquire personalised meaning, a special significance, through correlating the very fact of the dissonance with the activity in the course of which the incongruity has been discovered. The need must become actualised in non-contradictory activity.

6. The transition from surprise to perception is linked to the change in the activity's motivational structure. It is the result of change in assessments, meanings and goals. Assessments, as it were, unsettle attitudes.

The results of research under the third method tally with the above data. They indicate that the non-formal structure of

the situation (its meaning and value aspects) not only changes but is in itself a source of changing value assessment criteria (goal-formation, etc.) Attitudes become actualised through motives, goals and conditions, and assessments take part in the very process of actualisation of motives, formation of goals, and identification of conditions in the overall situation of activity. Attitudes are "responsible" for sustaining the trend taken by activity, assessments take part in developing this trend. Evolving while attitudes are being realised, assessments represent new goals which, becoming gradually objectified, "attract" activity and actualise new attitudes. This takes place against the background of realisation, through the force of inertia, of previous attitudes, which, in the long run, cancels them.

The methods of research into the initiation of thinking are based on the following principle: introduced into the material of the experiment, were possibilities for creating "a contradiction between the thought and the object", possibilities which did not, however, become an immediate obstacle for meaningful activity involving the material. One may say that what was pursued was initiative of a "higher"order than in the experiments in which the testee went beyond the boundaries of the requirements of a similar intellectual task offered by the experimenter and accepted by the testee. Initiation of thinking was studied as a moment of transition from non-thought to thought activity by creating an incongruity, a contradiction in the material, whose discovery could promote the formation of a concrete intellectual task on the basis of this contradiction. This, however, was not supposed to hamper the conduct of non-thought activity.

It has been shown that the processes of assessing an object-related situation (both emotionally and verbally) are a necessary component of goal-formation. At the same time, the goals themselves (which are changing) act as criteria of assessment. An analysis of the emergence of the cognitive need as the basis for the formation of new goals in the course of non-thought activity (and recognition of this as the key factor in comprehending such phenomena as "sensibility to the problem," "the ability to see the problem"), indicates that emotional assessment points to the possibility of posing a cognitive goal prior to the "act of objectivation". This directs and initiates the search before the discovery of the logical structure of the cognitive contradiction, on whose basis the goal is formed. Emotional assessment outlines the zone of elements without defining the object-related content of the contradiction. In its actualisation, the cognitive need produces a restructuring of activity.

This causes reproductive activity to turn into exploratory thought activity directed at discovering and precisely identifying the gap in the goal. The discovered contradiction may be assessed by the testee as an external one with respect to activity. This fails to promote the formation of an intellectual goal.

There is a link between emotional and verbal assessment at the stage when thought activity is initiated. Becoming aware of the goal, making it more specific, and concretely defining it takes place in stages. Gnostic goals may arise as a result of correlating the subject's object-related sensual experience with meanings or the object-related sensual content that is being reflected. In both cases, the dissonances in the process of correlation are represented in consciousness as emotional and axiological processes. The degree of probability of discovering the intellectual problem in the same material depends on the type of actions performed with this material. Activity takes place which is expressed in independent goal-formation and the transformation, on this basis, of instruction-conditioned activity into thought activity, even if this is not defined by the instruction and contradicts it.

V. Klochko has proved that the concept "objectivisation" (Dmitry Uznadze, Nikolai Eliava) is not enough to explain the mechanism of the discovery ("perception") of the problem, since an important link is missing which precedes and generates the very fact of objectivisation ("pause"). Occurring in activity, is the anticipation of the possibility to form a cognitive goal. An important role here is played by emotional-axiological processes. Emotional assessments are based on needs, which are objectified in goals, but not instantaneously. The transition from the need to an object-related goal is the transition from emotional assessments to verbal ones, from anticipating the goal to specifying it. Determinant in the situation of goal-formation are not only hindrances but the very possibility of posing a cognitive goal.

The change of motive in the course of activity produces a change in the elements' personalised sense. This determines the emergence of new conditions of new activity. In studying goal-formation in the course of solving a problem formulated by another person, it has become apparent that at the time of perceiving (reading) the task, the different elements of its conditions already acquire different senses and value for man's subsequent activity. These elements have different emotional hues and become fixed in different ways in operational memory. Conveying their significance and value for man,

the elements' emotional colouring in some cases predetermines the formation of goals that the subject advances independently and which begin to function earlier than the experimenter's requirement has been perceived. Independent gnostic goals emerging in the course of problem-solving are not an expression of the testee's "arbitrary rule". They are determined by the possibilities of goal-formation inherent in the situation itself and revealed during the subject's interaction with it. Independently formed goals turn into intermediate goals, which are linked to the final goal.

This tenet has been confirmed in using the modified "lead" method. The testees assessed the leads depending on that meaningful goal which they sought to attain at the time by performing certain actions. Intermediate goals performed the part of assessment criteria. Emotional assessment of the leads acted as the first "filter" manifesting itself as an attitude towards the lead. It either let the lead through or prevented it from getting to the level of verbal processing and assessment. Emotional and verbal assessments may enter into complex interactions with each other. This secures a return to the leads and their reassessment. Observation of the emergence of a hypothesis on the basis of a lead has made it possible to conclude that verbalisation of the hypothesis is sometimes preceded by the functioning of "pre-hypotheses", which arise with the participation of the emotional-axiological level. This paves the way for verbalisation in the course of repeated appeals to the "basic" lead, whose value and meaning change at each appeal due to the development and the increasingly concrete character of the goal. For the recipient, the requirement formulated by another person may appear (and indeed is) a discordant condition. This may force him to engage in goal-formation proceeding from the existing conditions perceived as the possibilities inherent in the problem's material.

The study of goal-formation in the course of problem-solving indicates that in case of complicated problems, there is an increase in the determinative role of the conditions which reveal through emotional and verbal assessments the possibilities for independent goal-formation. The goals that emerge may present relatively independent entities unrestricted by rigid links with the final goal. At the same time, the emergence of these goals is determined by the objective conditions allowing their definition that are inherent in the problem's non-formal structure reflecting the formal structure mediated by the motives (including the situational ones) and goals of the person who

has agreed to solve the problem. In these cases, regulation of search activity is carried out not only within orientation at the final goal. Assessments are formed not only for the criteria which this goal represents, as it were, from "above". The part performed by regulation "from below" gains in importance, as do the conditions, elements and the environment of the task within whose structure the testee discovers opportunities for independent goal-formation. The need for intermediate goal-formation stems from the fact that at a certain stage, the final goal does not correspond to the conditions of its attainment (the solution is not yet known). A person is forced to set more realistic goals proceeding from the possibilities he can discern in the situation that has evolved. If intermediate goal-formation is determined by concrete conditions (through their psychic reflection), whose structure reveals opportunities for goal-formation, this eliminates their rigid link with the final goal (at least at the initial stage of problem-solving), which is still established in the course of the search.

§ 4. Formation of General and Specific Goals

Soviet psychologists have made a comparative study of the following types of goal-formation: a) the formation of the general goal as a certain unspecified image of the future result; b) specification of the image, the emergence of a specific meaningful goal; c) the overall process of goal-formation embracing the formation of general and specific goals as consecutive phases.

The principal characteristic feature of the study of goal-formation on the basis of selecting a problem (the level of aspirations) consists in the fact that goal-formation is viewed only as a process based on the selection of means of attaining a definite result (product) within the available object field (a range of problems having a varying degree of complexity presented to the testees for solution). One of the devices used to create difficulties was the imposition of a time-limit. Acting as the mechanism for this type of goal-formation is the evaluation of future results of work for valency, or value, and the probability of success (the evaluations need not coincide). The formation of goals on the basis of selection of the task is only one type of goal-formation, the formation of specific goals. Identification of goals was initially executed from the qualitative viewpoint, proceeding from the testees' spontaneous verbal utterances, and then from the quantitative angle, using a graduated scale

of the problem's complexity. Orientation at predominantly quantitative indicators has created a situation in which ideal goals and goal patterns (described by F. Hoppe) were excluded from the realm of concrete research. Later, both situational and motivational factors of goal-formation were examined within the framework of the theory of achievement motivation. However, the stress was mostly on the formation of goals on the basis of selecting a task within a precisely outlined field (i.e., the simplest form of goa-formation), while the principal method was reduced to establishing correlations between the different "variables" in the goa-formation model. An important fact discovered in researching the problem of the level of aspirations were the dynamic changes in the valency (value) and the probability of fulfilling the tasks from which the selection is made.

The analysis of the evolution of goal-formation in the context of research into productive thinking has shown that Gestalt psychology, although it had not made it a point to examine goal-formation, obtained important data which may be interpreted as the fact of the change occurring in the general and specific goals in the course of problem-solving. The principle of the solution, which reflects certain general and essential properties of a problem situation and determines the general direction of the problem-solving process, in fact acts as the general goal. The processes engendering a new general goal are based on the inclusion of the object of analysis into new relationships and the transfer of this content to the conscious level. The mechanism of the formation of general goals is the assessment of the chances for changing the object-related situation, the prospects for its transformation, which may be executed not only consciously but also unconsciously, in the form of meaning and emotional assessment.

Some new research has considered the types of goal-formation as consecutive phases of a single goal-formation process. It was maintained that the formation of goals is based on reflecting the evolution of the object-related content of activity. Goals as activity determinants are indissolubly linked to determinants of a higher order, the motivation-sense structures, which regulate the formation of goal determinants. In order to study the different types of goal-formation, activity with varying levels of organisation was modelled. In the course of the experiment, testees were trained in a new activity. The training was conducted in several groups, in each of which different meanings and purposes of this activity were formed. Specifically, the testees were taught to play Kalakh. The different senses

of game-playing were formed by focussing the attention of testees belonging to different groups on different sections of the instructions, and by subsequent correction of their activity from the viewpoint of its meaning and purpose. The first group was oriented towards scoring as many points as possible in each game situation. The second was encouraged to transform game situations and create original and interesting combinations. The third group was urged to emphasise major combinations incorporating several moves, whose construction substantially transformed the game situation and whose success ensured scoring many points.

Before making a move, the testee was requested to substantiate it, i.e., give concise essential information concerning the nature of the goals he was setting. A situation was created in which the testee acted jointly with the experimenter against a strong opponent, a computer. The experimenter told the testee that he intended to help him by pointing out mistakes, but to do that, he needed information about the testee's goals. The actual opponent of the testee in the game was not the computer but the experimenter's assistant, who was in the next room. Communication between the opponents was maintained through displays. The explanations offered by the testees described the goals emerging in the game. Also used was the method of quantitative assessment of the result for magnitude and valency. In forecasting the magnitude of the result, the testee was asked to mark the number of balls he expected to win on the scale graded 0—2, 3—4, 5 or more. He was instructed to point out, using the scale, how many balls he *thought* he could win in the next move. Then he was asked to forecast the probability of winning the given number of balls using the subjective probability scale graded: high—medium—low.

The game of Kalakh involves two partners. The game situation includes twelve squares arranged in two rows (one per player). Each square has six balls. Besides, each player has an additional square, "kalakh", to the right of his six squares. The target is to get more balls to the "kalakh" than the opponent (Fig. 11).

1. The players take turns making moves, which consist of consecutively placing all balls located on a randomly chosen square into each of the squares, working counter-clockwise, one ball per square (with the exception of the opponent's "kalakh"). We shall term this action transference.

2. If the last ball moved by the player falls to his "kalakh", he gets the right to make an extra (prize) move (the right to

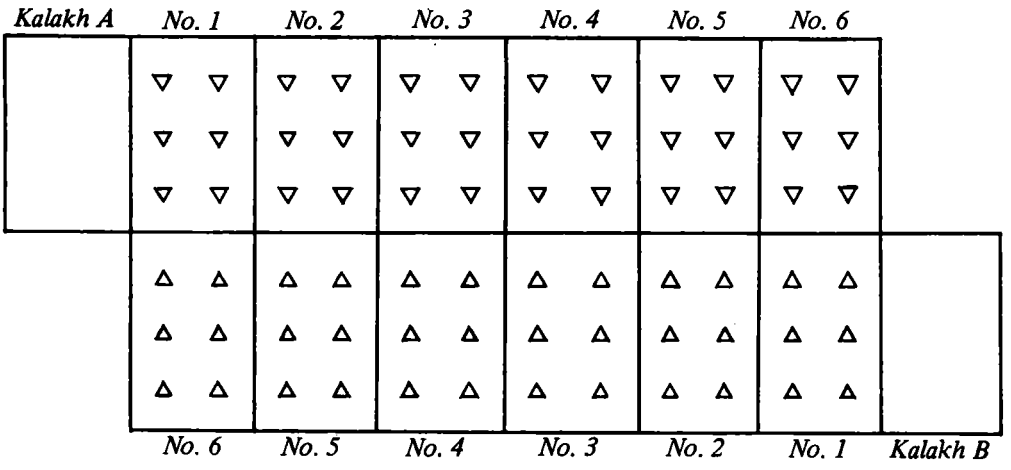


Fig. 11. Initial situation in the game of "Kalakh"

the prize move is retained irrespective of the number of the moves that have been made).

3. If the last of the balls falls to its owner's empty square, the player places this ball and all the balls located on the opponent's opposite square into his "kalakh" (the action termed capture).

4. The game is over when no balls remain on one of the partners' squares. The final score is established by counting the balls on the "kalakhs".

The following types of actions can be identified in this game: actions aimed at immediately realising the available opportunities (transference, capture, prize moves and their series); actions preparing such realisation (threatening the opponent's square—getting ready to capture); preparation for a prize move or combination, defence (removal of balls from the square under attack). Specific goals are those of actions to realise captures, combinations. General goals are those of actions preparing such captures, and combinations. The general and the specific goals differ in the depth of the determination of activity. Taking part in the experiments were young men aged 16-17.

The experiment demonstrated that in activity at the simplest organisation level, i.e., oriented towards realising the available possibilities of a game situation, the dominant form of goal-formation is setting specific goals. At more complex levels of activity, i.e., those oriented towards a preliminary transformation of the initial game situation, the dominant type is formation of general goals. Given the highest level of organisation, oriented at performing an integral process that would evolve a link between a preliminary transformation of initial situations

and subsequent realisation, the prevailing type is the formation of goal patterns incorporating both general and specific goals. Generation of these goals may have different mechanisms: a) assessment of the opportunities offered by an object-related situation, b) assessment of the prospects for transforming the object-related situation, c) comprehensive assessment of both the opportunities offered by the object-related situation and prospects of its transformation. It has been shown that the processes of forming general and specific goals are closely interrelated: when one diminishes in scope, the other is reduced to the simplest forms. The fusion of these two processes into a single whole, which includes the formation of general and specific goals as consecutive phases, secures a high level of each and prevents reduction to the simplest forms. Regulation of the different types of goal-formation is executed through a variety of motivational and meaning determinants. These are embodied in certain general tactical principles selected by the testees. A major dynamic characteristic of activity is conflict, whose core is the absence of correspondence between the testee's level of game-playing and the objective demands set by the opponent's game. The conflict makes itself felt in the progressively lower efficiency of activity; a close link has been observed between motivational and meaning determinants of activity and the evolution of the conflict. Their operation is enhanced or suppressed depending on whether the conflict is aggravated or relaxed. A change in the type of goal-formation occurs only when the level of organisation and purpose of activity change. Operational training in new methods of activity does not produce a change in the type of goal-formation although it promotes the expansion of the store of means. The character of the forecast of the result of activity for magnitude and probability is determined by the type of goal-formation.

§ 5. Assessment of Attainability of the Result as a Component of the Goal

Assessments of the result's attainability, of which the person is not always aware, are incorporated into the process of forming a new goal. Apart from a conscious image of the future result, a real goal also includes an unconscious assessment of the attainability of that result. These ideas have been confirmed by a series of experiments.

The testees taking part in the first series were given a set of geometrical figures (triangles, squares, rhombs, etc.) and

requested to use them to compose pictures arising in their imagination and to name these pictures. The testee continued to work until a second refusal (after the first, he was asked to go on). The experimenter then analysed the results identifying the group of pictures preferred by the testee (animals, buildings, etc.). At the second stage of the experiment, the testee was given a set of figures differing from the first one only in colour and told that it was a curious feature of this set that in using it, certain pictures were more difficult to make up (here, the experimenter named the group for which the subject had shown a preference), i.e., the suggestion was that with respect to a certain object-related field, the result was more difficult to achieve.

Three types of responses were observed in this situation: a) the number of figures which were supposed to be difficult to do dropped dramatically (by an average of 26.4 per cent). There were fewer attempts to produce such pictures, and the efforts themselves were curtailed. False explanations emerged: "I haven't got the necessary cards", "These cards won't fit". The testee set a goal but did not attain it; b) suggestive influence produced an opposite response: the number of "banned" pictures increased by an average of 20.3 per cent; c) suggestive influence made no impact on the testee's actions. The experiments demonstrated that at least occasionally, outside indirect suggestion can create an a priori assessment of the result's attainability, which functions together with the conscious image of the future result, and in this way regulates the subject's associative output.

In the second series of experiments, 20 adults were given sets of problems. In respect to the sums, the requirement was to find out which numbers in a preset sequence could be written down using three figures of 4 and the mathematical signs. In verbal problems, the testees had to decide which of the named pairs of notions have common features, and which do not, and in designer problems, to find out which of the given pictures could be assembled from the available set of figures. Objectively, all problems were solvable. In a preliminary series of experiments, testees were to categorise into "solvable" and "unsolvable" eight similar problems having the same degree of complexity. The classification had to be done on the basis of a "first impression", without first solving the problem, and to take up 1-2minutes. The instruction contained an indirect suggestion that the final result ("to solve the problem") was not always attainable. In the basic series of experiments, the testees were

to check the accuracy of their classification by actually trying to solve the problems. The experimenter recorded the efficiency of the solution, the time of the solution, the oral account, and the thinking out loud process. On the basis of the latter, the number of hypotheses was noted. Also recorded in case of the designer problems was the depth of the hypotheses' verification, the selection of figures, the number of discovered and undiscovered mistakes; in case of the verbal problems, the number of answers and the number of categories that had been employed.

In preliminary experiments, an average of 43 per cent of the sums and designer problems and 53 per cent of verbal problems were classed as solvable. All testees found reasons why they considered some of the problems unsolvable. The main series of experiments showed that 12 out of 20 testees were affected by preliminary assessments. On the average, the problems erroneously labelled as unsolvable presented more difficulties than those labelled as solvable. However, there were instances when the preliminary assessments exerted a reverse effect (four testees out of 12). In dealing with the sums, the direct influence of the problem's earlier assessment as solvable produces 61 per cent of correct solutions against 33 per cent after a negative assessment. The time was 5 and 2.5 minutes and the average number of attempts, 6.4 and 2.9 respectively. Solution of verbal problems did not demonstrate a substantial difference with respect to time, but under the impact of a positive assessment, the number of answers and categories used rose 150 per cent. In tackling designer tasks, the time doubled, and the number of hypotheses rose 250 per cent. Eighty per cent of the hypotheses rejected in the negatively assessed problems were objectively sound, while the corresponding figure in case of positively assessed problems was 30 per cent. The testees believed that they had spent an equal amount of time and effort to solve a problem.

In the third series of experiments, the testees were given specially selected problems in which the requirement was worded in a different way for each group. In the first case, the task was to assess solvability, in the second, to begin working, and in the third, to find two solutions. Actually, the problem had one solution. Here is one of the problems: "At a factory, cigarettes are packed 160 per box. They form 8 rows with 20 cigarettes in each, and fill the entire box. Is it possible to pack more than 160 cigarettes into each box?" The second version of the requirement read as follows: "Find the best possible way of

packing the maximum number of cigarettes into the box." The third was: "Find the two existing ways of packing more than 160 cigarettes into the box." The wording made the testees form different estimates of the attainability of the final result (to solve the problem). Experiments have shown that the most efficient work was done in the third case, when the requirement contained, as it were, an overstated assessment of the result's attainability, and the worst performance was displayed when attainability was put in question. The solution was found in 33, 67 and 92 per cent of the attempts respectively. The time of working on the problem and the number of hypotheses increased.

All three series confirmed the idea that assessments of the anticipated results' attainability are included in the process of goal-formation. The subsequent functioning of the goal in the course of the work to achieve it testifies to the operation of these assessments, of which the subject himself may not be aware. Attainability of the goals, the time spent to reach the goal, and the structure of the search for solution may all be among the assessments' functions. One of the ways of forming assessments is indirect suggestion, which may both raise and reduce the efficiency of activity. Consequently, the influence of assessment is relative. A suggestion has been advanced that assessments act through a change in motivation at the moment of the formation of a new goal.

§ 6. Mnemonic Components of Goal-Formation

One of the trends in the study of goal-formation is research into the role of memory in this process. Different types of memory exist, and for this reason, a general problem may be made more specific with reference to each of these types. Research has been done into the influence of affective memory ("emotional consolidation") on the process of goal-formation. Emotional consolidation of a certain situation element before the presentation of the entire problem led to a change in its subjective significance on the testees' scale of values, as a result of which this element was given preference in subsequent activity. The testees' return to actions involving the emotionally consolidated element was also observed when these actions had been negatively assessed verbally. The transfer (generalisation) of emotional experience from the preliminary to the main task was carried out at the unconscious level.

The part played by affective memory in goal-formation was

studied through a comparative analysis of the solution of a problem. Some of the testees were made to emotionally consolidate objectively insignificant, and others—objectively significant situation elements. In the first case, the results were as follows. The testees did not evolve a verbalised general idea (general goal). Proceeding from the subjective significance of the consolidated element the system of intermediate goals was constructed. The development of the operational sense of the emotionally consolidated element took place in an intermediate situation. This operational sense had maximum scope. The intermediate orientation zones were selected by the testee in conformity with the possibilities offered by actions involving the emotionally consolidated element. The subjective significance of the consolidated element entered into conflict with its objective significance. An "emotional solution" of the problem did not emerge. In the second case, when an objectively significant situation element had been consolidated the outlook was different. The testees verbalised the general idea of the solution. Intermediate goals, whose number decreased, were linked by an objectively significant situation element within the general idea of the solution. The element's "emotional development" and the formation of its operational meaning were reduced. In each intermediate situation, the operational sense of all elements was subordinated to the general idea of the solution. The search zone was cut down, as was the formation of operational senses through rejection of actions involving the elements that had nothing to do with consolidation. Within the framework of the general idea of the solution, only those elements were involved which pertained to the actions incorporating the consolidated element. The structure of the testees' search changed, and this brought nearer the emergence of the "emotional solution". The experiments confirmed that affective memory indeed plays an important part in the preparation and emergence of new goals.

A study has been made of the effect of loading short-term (predominantly image and operational) memory created by the specific features of activity, as well as the content and the dynamic characteristics of the goals that are being defined. Used in the experiment was the problem represented on Fig. 3 (see p. 20 ...). A comparison has been made between the graphic-representational and graphic-operational solution of the same problem by different testees, i.e., involving an additional load on memory in one case and its absence in the other. The testees had to retain in memory the conditions of the problem determining

the permissible and the sufficient transformations of the conditions; the requirements set to the final and the intermediate results; the dynamic changes of the problem's conditions represented in a graphic form; the intermediate and the final results of problem-solving. The experimenters recorded the time needed for the solution, the results of solution, the testees' utterances which were compared to the actions that were objectively possible at a given moment, the combinations and the means of transforming them. The testees' remarks made it possible to form a judgement concerning the goals they were defining. Also recorded were their eye movements.

Experiments have shown that qualitative characteristics of goals are dependent on how distinctly the testee remembers the representations of the anticipated situations, their transformations and interaction. The evolution of the transformation of goals depends on the transformations occurring in memory: the sooner the solution effects the transition from the prevalence of image memory, which registers visual situations, to memorising actions, the sooner the transformation of goals occurs. Mnemonic transformations (schematisation) are effected in the course of repetition of accomplished operations and re-examination of the elements of the problem's visual structure. Excessive load placed on image memory, which entails the emergence of mnemonic orientation and the setting of mnemonic goals, may hinder the formation of gnostic goals aimed at solving intellectual problems.

Three stages have been distinguished in the transformation of goals depending on the nature of the situation representations retained by memory and the ways of their transformation. The experimenters traced the functions and interaction of voluntary and involuntary mnemonic components at each of these stages. At the first stage of the emergence of the goals directing thought activity, primarily involuntary mnemonic components take part. At the second stage, voluntary components become involved, and this leads to the formation of intermediate mnemonic goals. At the third stage, voluntary and involuntary components are balanced.

It has been established that the material of the problem situation is organised in the subject's memory on three levels, which provide the basis for forming the goals in the course of the three stages of goal-formation: 1) the formation of spatial structures of the problem situation; 2) involvement of the operative components of the solution; 3) joint functioning of the spatial and the operative components. Two types of goal-forma-

tion have been identified, and the dynamics of their correlation in the problem-solving traced. The goals formed "from above" include a fairly small number of visual representations and a large number of forecast operations. The goals formed "from below" contain detailed representations of positions and insignificant amount of forecasting. In the course of mental search, a tendency has been observed towards a gradual transition from goal-formation "from below" to goal-formation "from above". Subjective units of thought activity have been discovered, which are shaped by establishing ties between problem-solving operations, forming "operation chains".

Experimental research has highlighted the dependence of goal-forming processes constituting the most creative link in intellectual problem-solving, on the load placed on short-term memory. This dependence is a manifestation of the unity of memory and thinking in man's activity.

Chapter Six

THINKING AND COMMUNICATION

§ 1. Thinking in the Structure of Interpersonal Cognition

Soviet psychological science has recently laid a certain stress on what has been termed "the psychology of interpersonal cognition". Among the problems studied within this trend are "first impression", "recognition of emotional manifestations", mutual understanding in joint activity and communication, the feedback established when one person perceives another, perception of and impact on another person, the phenomenon of social attribution. The main idea behind these studies is to understand the psychic reflection of "the world of people" as distinct from "the world of objects", to analyse the gnostic component of communication.

The formation of concepts concerning another person's personality was analysed, among others, in the works of A. Bodalev. He studied the role performed by a person's occupation, age and sex, and examined people's interpretation of facial expressions and gestures. Another question within the scope of his research was the function of the concepts formed about other people in regulating man's behaviour. He also analysed and purposefully cultivated the personality traits which make a person good at understanding others.

However, "the psychology of interpersonal cognition" is not an independent branch of psychology but an aspect of psychology of communication. It is a particular case of cognition that also incorporates thinking. In the situation when one person tries to understand another, thinking is singled out as an independent object of research if a line is drawn between a) perception and thinking; b) the results of cognition (the images and concepts) and the very process of cognition (this is seldom done in works on social perception). In order to correctly correlate the works on psychology of thinking and on social perception, one has to remember that the term "inter-

personal cognition" is in fact used provisionally. The matter at issue is not just any form of cognition but only empiric cognition, which does not make use of scientific concepts and methods. Strictly speaking, any experimental psychological research (e.g., measuring the sensation threshold) involves cognising another person.

Thinking as a component part of communication in the process of people's joint activity may act in a variety of capacities: 1) interpretation of another person's reactions and movements (he is flushed—this means he is agitated); understanding (interpreting, explaining, forecasting) the results of object-related actions (directly observed or previously registered) of another person and of activity as a whole, of an individual act (he gives me things, consequently, he likes me); 3) understanding verbal output (oral and written). Thinking becomes full-scale solution of an intellectual problem when in a situation of interpersonal interaction, a line has to be drawn between the different meanings of expressive movements or responses, when controversial information supplied by a person has to be deciphered.

Interpersonal cognition includes forming concepts about another person's way of thinking, the style of his thinking, what he thinks about us, what he thinks about what we think about him. Cognition of another person is understanding his goals and motives, the problems that he is trying to solve and that are significant to him. It is also the ability to look at an object-related situation and at other people with the eyes of this person. For example, to try and evaluate one's lecture from the point of view of a student, to make an effort to see the opponent's point in an argument. Research conducted by Jean Piaget indicates that the ability to see the other's point of view is not formed immediately but necessitates overcoming the barrier posed by egocentrism. The need to take account of another person's reasoning is clearly seen in the following situation:

"Three sages of old argued about who was the wisest. The dispute was settled by a passer-by, who suggested that they take a test for quickness of wit. He showed them five caps, of which three were black and two—white. Then he told them to close their eyes, put a black cap on each man's head and hid the two white ones in a bag. He then allowed them to open their eyes, and asked them to make a guess as to what colour was the cap each of them was wearing. The sage who gave the right answer would be the wisest.

"Each of the sages saw that his opponents were both wear-

ing black caps, which meant that two out of three black caps had been used. Proceeding from immediate perception and the knowledge concerning the total number of caps, each of the men could advance two equally plausible conjectures: he was wearing either a black or a white cap. To solve this problem, one has to consider how the subject is perceived by others, and of what significance this may be in selecting one of the alternatives.

"Sage No. 1 reasoned: If I were wearing a white cap, sage No. 2 would reason: 'if I were wearing a white cap too, sage No. 3 would have realised right away that he is wearing a black cap, since there are only two white caps.' But he is silent, which means that I am wearing a black cap, and in that case sage No. 2 has no trouble solving the problem. But he says nothing, since he sees not a white but a black cap, and I have reason to say that this is so."

It is significant that in this problem proof of the greatest wisdom is the ability to fathom another person's reasoning. In trying to understand another person, the need arises to weigh the personal and the situational factors affecting his behaviour, to correlate his behaviour to one's own, to consider the influence exerted by the role assumed by another person on his behaviour, and to take into account not only those actions that have actually been performed but also those that have not.

Let us look at some of the manifestations and features of thinking in the situation of conflict. Conflict involves an opposition of persons, their goals and motives. The number of persons involved in a conflict may vary, for the sake of simplicity, we shall keep it down to two. Under the conditions of conflict, thinking acts as motivationally and personally conditioned. Participants in the conflict try "to think for the opponent" (this form of thinking is sometimes called reflection), which is essential for forecasting the opponent's actions and planning one's own behaviour. Participants in the conflict have an attitude of fighting, which manifests itself in negative feelings towards the opponent. The results of the work to solve a mental problem are immediately tested by a critically-minded opponent who does his best to find a mistake in the other side's plans and ideas and to use it to turn the tables, which, naturally enough, makes the other person take a more responsible attitude to mental work. Another factor to be taken into consideration, is the possibility of intentional misinformation (disguising one's plans) to which the opponent may resort. The opponent's plans may be gathered in two ways. First, considering his personality, and second,

analysing the object-related situation (i.e., considering the subject and the object of his activity). Neither should be treated as all-important. An analysis of the opponent's personality traits should be made in the context of the situation, the objective conditions of the struggle. When the situation is not distinctly outlined, or when the opponents are equals, a correct assessment of the opponent's personality traits is particularly important. A person tends to display enhanced creativity when the conflict gains in acuteness.

A major aspect of understanding the opponent is to pinpoint the individual style of his thinking, which manifests itself in the peculiar way he interprets and appraises problem situations and the formation or choice of means of further practical action. In a situation that permits a definitely optimal single solution, which is easily fathomable, it is difficult to distinguish the opponent's personal traits. A unique study of chess players' style has been made by N. Krogius, whose basic method of research was analysis of games. The scientist also registered the productivity of the game and the time taken to work out a decision. He sought to pinpoint the solutions which he believed to be the most typical of a player that he produced at the turning points of the game, as well as noticeable mistakes in evaluation and planning. This was done in order to associate the player with a typical style of chess playing in accordance with a previously developed classification. A detailed analysis of the players' work was made at each stage of the game (opening, the middle, and the end game). The most valuable material has been yielded by the analysis of the middle game, which contained the largest number of problem situations.

An analysis has been made of Max Euwe's work in the middle games throughout seven years (1920-27). He was selected for a number of reasons. First, his game has been little analysed, and this reduced the risk of being influenced by earlier assessments. Second, the researcher had at his disposal notations of 483 games played by the ex-world champion, which is nearly all he played at that time in serious tournaments.

In identifying and systematising the basic elements of chess strategy and tactics typical of the middle game, N. Krogius compiled a "dictionary of meanings" of chess ideas applied by Max Euwe in the middle game (a hierarchy of strategic goals). His game was analysed for frequency and efficiency of choice of a certain preferred goal. Comparative analysis has made it possible to chart a scale of subjective values by which the player was guided.

The scale means that, given a number of more or less equivalent choices Max Euwe usually preferred to win a pawn than to continue attacking the opponent's king, to have two bishops against a bishop and a knight. And, most characteristic, he invariably placed primary importance on defending his own king.

To sum up. The other person's goals constitute a major object of interpersonal cognition. Under the conditions of conflict, it becomes more difficult since the real goals are concealed and false ones are flaunted. Understanding the goals is part of forming a more general idea of the opponent's creative thinking.

A characteristic of individual style of thought in a conflict situation also incorporates taking account of by-products of the chosen goal (expected losses in working to attain the goal), as well as an allowance for the opponent's success in reaching certain goals (concessions).

Recognising the possibility of unusual concessions which are not self-evident is a sign of originality of the goal. Stable preferences in choosing one's own goals, devices and concessions characterise the individual style of activity as a whole and are associated with such characteristics as "originality", "complexity and depth of planned actions", "definitiveness of expected results", "flexibility in making and modifying plans", and "precision in achieving planned goals".

A revealing situation is that of negotiations, in which the partners have both common and diverging interests. The latter give rise to all sorts of maneuvers and subterfuges which are designed to disguise one's own position, goals and interests (motives). These include placing emphasis on a relatively insignificant goal, over-reacting, and confronting the other side with deliberately exaggerated demands.

Studies dealing with interpersonal cognition draw a distinction between identification and empathy. Identification is the simplest way of understanding another person; it is based on an attempt to put oneself in the other person's shoes. Empathy is emotional response to the other person's problems. Thinking (understanding) is represented in different ways in indentification and in empathy, and this difference merits a special analysis.

Interpersonal cognition includes *causal* interpretation of another's behaviour. This interpretation, i.e., mental work, may be of two kinds: a) looking for and finding real causes and b) attributing them to a person. The latter case has provided subject-matter for studies dealing with causal attribution. Causes may be attributed to circumstances or to persons. The

various errors in attribution and the conditions affecting its character have been systematised. The problems of thinking arise in situations when new attributive schemes are considered.

The most complicated aim of interpersonal cognition is understanding the other person's real motives and the true meaning of his activity. A problem that frequently arises is to differentiate between unconsciously attributing uncharacteristic motives to a person (involuntary attribution), and deliberate attribution (*intentional* slander).

§ 2. Thinking as a Way of Influencing Another Person

Thinking plays a role not only in the overall effort to understand another person, but also in preparations (thinking out) of ways to influence him. This influence manifests itself, specifically, in attempts to restrict the cognitive opportunities available to the other person (as in the case of conflict) or, on the contrary, to expand them (in the situation of cooperation). For example, disguising one's plans is an example of trying to restrict the opponent's cognitive opportunities. The influences exerted on another person's psyche may be "addressed" predominantly to thinking (misinformation, persuasion) or to the emotional and volitional sphere (to shock the opponent, disorganise his activity by instilling a feeling of insecurity). To work out the general principles and to make effective use of them in a conflict is one of the functions of thinking.

The formation and application of the general principles in affecting the opponent's personality include: a) making things as difficult as possible for him (creating tricky situations, behaving in a certain manner); b) disguising one's intention and misinforming him; c) activeness. In a conflict situation, false threats and diverting strikes are used for the purpose of disguise. When misinformation has succeeded, attainment of the real goal has a psychological side effect, suddenness, unexpectedness. Non-stereotyped actions are more difficult for the opponent to foresee, and for this reason are doubly valuable, possessing objective significance and affecting the opponent by virtue of their suddenness. A number of methods employed in fighting an opponent have been evolved. Selecting the device and making it more specific are manifestations of thinking in a conflict situation. Also among the devices is displaying submission to the opponent's goals and plans, influencing the process of formation of his goals and plans ("coaxing", "biding one's time"), demonstrating one's own

goals (real or false, individual goals or a set of goals), and advancing "adventurist" goals.

A peculiar form of struggle, i.e., affecting the opponent, is used during talks (it is sometimes called extortion). One of the parties advances a demand which means nothing to it and is detrimental to the other party's position. This is done deliberately in order to extort a concession in exchange for withdrawing this demand.

Very often, communication includes one person giving advice to the other in a situation of cooperative, joint activity. Advice may differ as to content, form and insistency of its presentation to the partner. Sometimes it falls into the category of "what I myself would have done in your shoes" or promotes an opposite course of behaviour. One of the paradoxes of communication along the lines of advice-giving has been described in La Rochefoucauld's *Maximes et réflexions diverses*: "Old men are so fond of giving good advice because they no longer can set bad examples."

The paradoxes of "advisory" communication may also lie in the fact that giving advice, i.e., forming a programme of action for another person, is much easier than acting it out. "There is nothing we are so lavish with as advice."

A major feature of interpersonal communication is that it is determined and mediated by the motives of the persons taking part in communication. The side asking for advice is guided by certain motives which may be deliberately disguised. The side giving advice is also guided by definite motives, which in turn may be an object of conscious concealment. Their relationships may be represented as in the following pattern:

The giver's real motives		The recipient's real motives
	ADVICE	
Thee giver's apparent motives		The recipient's apparent motives

An important feature of communication is the ability to listen and to give answers. Hence the notion of a "good conversationalist". Among the components of communication are interest in one's fellowmen and oneself, direct expression or concealment of this interest, and awareness of the norms of communication. Paradoxically, a person may answer

not the other person's remarks but his own thoughts. The other person's remarks and his advice are always subjected to mental analysis, and therefore one sometimes needs just as much brains to use good advice as to give oneself good advice. The person's attitude towards his interlocutor is also manifested in how often he is told the same stories and given the same information. The leading role of personal relations as compared to the strictly intellectual components of communication has given rise to the aphorism, "It is trust, not wit that feeds a conversation."

We have considered communication along the lines of advice-giving, and mostly with reference to personal matters. However, advice-giving situations occur all the time in all, even the most complex, types of human activity, including the military field and politics. In his memoirs the distinguished Soviet military commander V. Chuikov made a great number of fascinating observations pertaining to communication and uncovering its frequently paradoxical nature, which are of great interest to a psychologist.

The book contains a vivid description of an extremely tricky situation in which Chuikov once found himself: "I was on my way to a person (Chiang Kai-shek) who could not be trusted an inch. I was going for the purpose of *helping* (italics are mine—*O.T.*) him combat an aggressor who had invaded his country. We knew that Chiang Kai-shek was waging a war against Japan in an alliance with communists, whom he considered his number one enemy. We were on our way to a dealer, a swindler, a huckster, who, given certain circumstances, would not have hesitated to betray his motherland and his people. I was on my way to help the Chinese people to drive the foreign invaders from their land."

Communication may include an element of criticism. It is important to watch out for the partner's response and to make sure that a negative response to criticism does not disrupt the very process of communication, does not undermine the chances for the partner's acceptance of even the most sensible advice. An illustration may be borrowed from the same book of memoirs. Here is an excerpt where Chuikov gives a description of an adviser's participation in combat operations: "A Chinese general decides to attack or to take up defence. His decision may have many oddities, to put it mildly. If the adviser openly criticises the plan, he will make an enemy; at best, the Chinese general will ignore him and will not invite him to take part in working out further plans and decisions. In any case, in exami-

ning a decision or a plan drawn up by a Chinese military leader, the adviser must declare it good, if not superb, for everyone to hear. However, under the pretext of making it more intelligible to the general's subordinates, he would ask for permission to introduce certain 'specifications'. One can bet that, his plan having been extalled, the general would be sure to give such a permission. Under the pretext of 'minor changes', the adviser may include in the decision everything he considers necessary. This kind of help would be accepted, and the adviser's suggestion will be acted on as the plan drawn up by the Chinese commander himself. In the event of the plan's or decision's achieving the desired result, the adviser should efface himself and loudly give all the credit to his general, while in case of failure he should find excuses vindicating the commander's and the troops' actions, and even congratulate them on their victory."

§ 3. Thinking and Communication

It is an accepted theory that communication has a perceptive, an interactive and a communicative aspects. Examining the latter, we come up against a number of paradoxes.

"How long do mice live?" asks the teacher. "This depends on the cat," answers the pupil. Has the pupil given a correct answer? On the surface, yes. However, we sense that this answer in a way is paradoxical. Why? The question refers to an average life-span of the mouse as a biological species, while the pupil implies that mice are often caught by cats and that for this reason, the life of an individual mouse usually ends at the moment of its encounter with the cat and depends on this encounter. Thus, a remark may lend itself to several formally correct interpretations (sequences of meanings). What is implied at this given moment is the actual *senses* of the remark. Paradoxes of communication often arise when the interlocutors read different senses into the same remark. Naturally, this hurdle must be overcome to make the progress of communication smooth enough. In this example, the ambiguity appears as a result of the pupil's answer, which exposes the other meaning of the remark. If the conversation is to continue, its participants must choose the sense they will pursue. In this case, sense is made obvious through verbal (linguistic) context, and therefore this type of sense may be called contextual.

If an isolated remark has been uttered, its actual sense

may be pinpointed by correlating it to the situation of perception and action; otherwise, the sense may remain ambiguous. For instance, the phrase, "I met the girl I love in a forest with bird-cherry" may mean that either there were bird-cherry trees in the forest, or that the girl war carrying some blossoming bird-cherry branches. If we actually witness this encounter or see it in a picture, the ambiguity is removed. In this case we can speak of a situational meaning.

"Our physics teacher talks to himself. And what about yours?" "Same here. But he doesn't realise it. He thinks we are listening to him." This example makes use of the double meaning of the expression, "to talk to oneself": to talk when an interlocutor is absent, and to talk when he is physically present but not listening. This example also illustrates another important feature of communication, which is a source of possible paradoxes: communication is characterised not only by how deeply each of the partners is really involved in it, but by the ideas entertained by the partners as to the degree of the other's involvement. When we believe we have a partner whereas in actual fact he is absent, the paradox of "talking to oneself" arises. Incidentally, this sort of thing happens not only when one person is addressing a group but when a number of group members talk all at once. Jean Piaget called this phenomenon "collective monologue".

Another example. A watchman has caught a boy stealing apples. "You rascal," he says. "Now I'll teach you how to steal!" "Oh good!" replies the boy. "I need to be taught—I've been caught three times already!" The paradox is built on making a literal use of the metaphor "to teach how to do something". The boy understands the watchman's words literally, and the watchman metaphorically (punish the boy for stealing). Naturally, a metaphor may be used literally either unconsciously or intentionally; in the latter case, it has a potential as a counter-blow, as revenge for the damage that has been done. And, finally, the last type of paradoxes, also illustrated by an example. A philosopher strolling along the beach was shoved by some man, who said: "I am not in the habit of making way for fools!" "And I have just such a habit," replied the philosopher and stepped aside allowing the man to pass. The paradox here is re-addressing one partner's characteristic to another, which is done by performing individual actions in the situation.

Thinking and dialogue. The fact that the most developed forms of human consciousness are associated with speech is

indisputable. However, the great number of types of speech (oral and written, dialogue and monologue, external and internal, voluntary and involuntary) necessitates a differentiated approach to the "variants" of the unity of speech and thinking with reference to each type of speech. A monologue makes mention of or even describes a situation, is based on a previously evolved plan, which is a result of thought activity, and makes selective use of linguistic and expressive means.

Let us consider in more detail the relationship between thinking and dialogue. This type of communication may be direct and mediated (correspondence). Distinguished within dialogue are voluntary and involuntary components and their correlation. Dialogue may be, first, a kind of response, consisting of involuntary speech responses to a speech stimulus or to remarks whose content and sometimes even form, have been "imposed" by an earlier remark. In this case, dialogue proceeds independently, with each new remark wholly determined by the situation and the previous remarks (the context), very important here are various clichés and set phrases. However, dialogue may also be voluntary (the second type) and be constructed along the pattern: a thought-out question—a thought-out answer (conversation, argument, giving an explanation). Among its characteristic features are forming an idea of the answer, building an independent programme of a remark, the choice of lexical and grammatic means, forming a reply to match the question.

The psychological conditions accompanying direct speech communication having the form of dialogue are as follows. Its participants know a certain object-related field (the subject of the conversation, the subject of the utterance). They perceive each other acoustically (sounds, including intonation) and visually (facial expression and body language). Thus we see that verbal communication is necessarily accompanied by non-verbal one. The interlocutors have common past experience (community of apperceptive masses). The tempo of communication determines the opportunities for thinking out the next utterance (emergence of new ideas), selection of the means and the motivational features of building an utterance. The two components of dialogue are "the address content" and "the response content". Speech communication is, as it were, superimposed above non-speech communication. Simpler "communicational structures" consist of inducing activity or attracting attention to an object with the help of gestures or eye movements. Research into children's speech has shown

that when a child masters his first words, he *has* already *mastered* the simplest communications procedures described above.

In case of voluntary speech communication, the verbal influence may be addressed primarily to one of the two principal aspects of psyche, the intellectual or the emotional. The goal of the subject of speech (the speaker), the speech plan or idea (the earlier term is "speech will") may be manifested in a variety of forms: *selection* of a certain style of speech, the use of expressive *intonation*, attempts to actively *influence* the interlocutor's *answer*, to *anticipate* this answer (anticipations of the answer affect the idea of the utterance). The goals of speech may be imparting information, a discussion, a conversation. In a voluntary dialogue, the goals of the remarks made by the participants are connected by certain links. The speaker's goal may be expressing consideration for the listener's individual traits, the possible difficulties of understanding, or likely objections. The goal of the listener may be grasping the speaker's idea and using it in producing his answer. Distinguished in dialogue are the functional types of utterances ("question", "answer"), which may be performing either their inherent direct functions or be used in a non-specific function. For instance, the question "Have you made the phone call?" may imply not only a request to give a positive or negative answer but also to perform a certain action. In developed speech, a substantial role in removing the ambiguity, i.e., forming the contextual meaning, is played by intonation. The same remark made in the same object-related situation may have different meanings.

A major feature of speech communication is segmentation of the meaning to be expressed into what is implied and what is actually expressed. The shares of these two components in the utterance may vary. When implication outweighs actual expression, a specific form of dialogue, "communication by hints", emerges. Silence is also a significant element of communication. Dialogues are distinguished on the basis of whether they are stereotyped or not. Lev Shcherba, a distinguished Soviet linguist, believed that new words, linguistic forms and phrases are coined in the course of dialogue, and that meanings become expanded. He regarded dialogue as a natural, and a monologue, an artificial and more conservative speech form. The positions of the partners in dialogue, the correlation of their knowledge concerning an object-related situation, their apperceptive masses and goals may change. A developed form of communication in the form of dialogue are negotiations

(commercial, diplomatic, military). Depending on the length of an utterance, dialogue may grow into an exchange of monologue-like utterances.

In the course of communication, a number of goals emerge, e.g., to establish and maintain contact with the partner (the phatic function of speech), to prepare the listener for perceiving and comprehending messages (fascination). With respect to the final goal, influencing the partner, they are intermediate ones; their emergence is also a result of certain mental efforts. It is believed that phatic communication depends in the least degree on the interlocutors' intellectual levels. The signals of fascination are concessions of a kind to the listener's interests. In one of the research studies in the field, the experimenter created a situation of competition between the partners, each of whom was to make up a more interesting story than the other. The basis of the story was an essay on a historical subject which, in the testees' opinion, was not interesting. They were allowed to make whatever additions (including fictitious information) and omissions they chose. The experiments demonstrated that to attract the listeners' attention and establish contacts with them, the testees employed not only customary but also original techniques (i.e., those they had thought up themselves): they referred to the authorities that the original text did not mention, used rhetorical exclamations, disrupted the listeners' attitudes, introduced new characters, and built situations based on episodes from well-known literary works.

A psychology textbook will tell you that *speech* is a specific form of communication between people executed through linguistic means. The two main functions of speech are imparting information and inducement to act. However, language is also used to *conceal* one's thinking. The need to do this, and to discover the thoughts that the partner in communication is trying to hide, engenders a number of features typical of the process of communication, which also render it paradoxical. Such actions may include avoidance of a directly posed question, asking unexpected questions and pretending that such questions are accidental, attempts to make the other person disclose what he knows but is trying to hide, preparing answers to anticipated questions in advance, looking for an excuse to pose any questions, asking pointed and tactless questions, attempts to find out just what it is that the partner is trying to conceal (trying to extract something useful from received misinformation), sounding out the partner's opinion, efforts to feign ignorance and evade a question, caution in

wording the answer, counting on one's words to be passed on to a third party, provocative hints, and the wish to make things difficult for the partner by asking seemingly irrelevant questions.

Participants in communication may use a variety of techniques. The paradox may be produced by one of the partners using a means in the capacity other than that in which the other partner had introduced it. "We knew," Chuikov wrote in his memoirs, "that bugs were planted on the premises, but believed it useless to get rid of them or put them out of order. On the contrary, we tried to use them to feed disinformation to the service that had installed them."

§ 4. Regulation of Thought Activity

Let us now consider the question of how another person's cognitive activity can be regulated, a question that brings together the issues of influence, communication and cognition, the component parts of communication that we have considered.

Influencing a thinking personality. We have already had a chance to observe how complicated and many-faceted thinking is, and it is therefore natural that the ways, methods, devices and forms used to influence thinking are also extremely varied. In trying to influence the evolution of thinking and forming thought processes actively and in a planned fashion, it is important not to attach overwhelming importance to any one approach to the formation of thinking. The most important and most complicated way is regulating creative thinking by influencing the thinking personality, by changing its motives, attitudes, positions, assessments and self-evaluation. It is this difficulty that makes researchers use such an "unorthodox" method as hypnotic suggestion for research and even educational purposes, which makes man change his ideas about himself and his abilities but which also leaves him his capacity to act within the boundaries of the image that has been suggested to him. It has been proved that a capacity for the arts, as well as attention and memory improve substantially when a person had been suggested the image of a "gifted personality". It deteriorates when the image has been that of a "barely literate man".

The testees taking part in a series of experiments were to make various uses of objects and to compare concepts in their normal state and in the state of hypnotic trance. Their instruction was: "Think of uses for this object. Give as many answers

as you can. Do not be confused by the strangeness of the task, express whatever you happen to think of." The time was not limited, the experiment continued until the testee refused point-blank to continue working with the object. In the course of the experiment, each solution was praised, and the instruction was regularly repeated. When the testee stated he was unable to think of anything else, he was given a 14-minute break, and the same assignment once more. During the break, the experimenter chatted with him on a subject that the testee enjoyed but which had no relation to the experiment. The break was made because the work to solve the task can proceed at the unconscious level, when a person stops consciously working on it. As a rule, the testees came up with another answer or two after the break. Then the testee was requested to visualise himself as a man of outstanding abilities, and to think of yet more answers. Not a single one was able to add anything to what he had offered earlier. This served as a reliable indication that a maximum number of answers had been received which can be expected from the testee in his normal state. The task took about an hour.

The objects employed were a key, a clothes brush and a scale. The object was not only named but also represented as a picture. It was assumed that basing themselves on both the mental idea and visual perception, the testee would be able to give more answers and actualise a larger number of properties, as they were represented pictorially. Then account had to be taken of the opinion that in the state of deep hypnosis, the psychic cognitive structure is devoid of abstract thinking. In analysing the comparisons the same methods were used. The testees were asked to find as many points of similarity as possible between two objects. The same analysis had to be made with regard to points of distinction. The pairs of objects for comparison were: skis and a hare, a goat and pincers, a steam engine and an airplane.

After performing the task in their normal state, the testees were then hypnotised. It was suggested that they were great scientists or inventors, and were asked to perform the same tasks. Their instruction was: "Please tell us what these two objects have in common, and how they differ" (in comparing the concepts) and "How can this object be used?" (in looking for possible uses). The testees were given an additional stimulus through questions of the type "And how else?" "And what else?", but on the whole, the orientation was less rigid than before the hypnosis to prevent fatigue. The experiments in-

volved seven adults between the ages of 20 and 27 with various educational levels who had proved susceptible to deep hypnotisation. The results were checked against the reference group comprising ten people, who were not susceptible to hypnosis. The conditions of examination were the same in both cases for both groups. Moreover, the performance of the experimental group was compared to that of a group of actors who were asked, after performing the task in a normal state, to "live" the part of a great man and perform all the tasks once again so as to have comparable data.

The results of the search for uses of objects were analysed for two parameters: a) the overall number of answers, and b) the number of transfers from one category to another, i.e., the use of the object's various properties (for instance, a brick was used as a paperweight or for making red powder). The first two criteria were the factors determining divergent thought processes, which are the most important ones in creative work. The results of the study to compare concepts were evaluated for the overall number of answers and the number of points involved (separately when finding the similarities and the distinctions).

Analysis of experimental results indicates that the average value of the indicators for which the results of the assignments were analysed, were somewhat higher in all experiments in the hypnotic series, and in some cases the same. However, a closer study of the results revealed that substantial distinctions existed between the two states. Despite the fact that the experiments under hypnosis were conducted later than the other series, the assignment that required finding uses for objects yielded new solutions and ideas, the testees found new uses (as compared to the previous series) for the objects, something they failed to do in their normal state, even after a break. The number of new answers found in the hypnotic state was very considerable. On the average, the testees discovered nine new uses for an object, with the average overall number of suggestions equalling twelve. Despite the fact that, once hypnotised, they did not remember that they had already performed the tasks, did not recognise them and perceived them as entirely new, the number of duplicated answers was only three. It is interesting that the testees' responses to the request to perform the task differed greatly in the two cases.

In the series not involving hypnosis the testees were slightly wary, since the task was totally new to them, belonging as it did to a field in which they had had no chance to test their abilities.

The testees were to discover non-traditional usages for things that were entirely familiar to him. As a rule, they began work by saying, "All right, let's give it a try. Let's see what I can do," and, while working, were waiting for the experimenter's reaction and kept asking if they were doing all right. When hypnotised and peforming the part of a "great man", their behaviour changed drastically. They felt confident, "looked down" at the experimenter and spoke in slow, measured, dignified tones. Upon being given the instruction, they said something like "I am now beginning. Be ready to take it all down." Often, they offered not isolated answers, as was the case in their normal state, but a whole discourse of a "philosophical" nature. They were quite indifferent to the experimenter's interruptions, objections, criticism and remarks. In such situations they began, at best, to explain "self-evident truths" or, not paying any particular attention, continued what they were saying. One of the reasons why the testees did not repeat the answers they had given in their normal state was the fact that the image that had been suggested to them made a number of answers unacceptable to them.

One of the participants in the experiment was subjected to an additional test. Listing all the uses that could, in his opinion, be made of a brush, he was asked why he had overlooked several other usages that he himself had mentioned in the non-hypnotic state. He indignantly replied that "he could not possibly have said anything like this" and that it was "no good expecting such answers from him". The experiments involving hypnosis also demonstrated changes in the number of properties forming the basis for a usage. The average number of new properties, which made it possible to use the object in a new capacity, was 7.5 in the state of hypnosis i.e., new answers were not based on using the already discovered properties in new situations, which would have formally increased the number of new answers, but on the testee's gaining a new vision of the old object, noticing those of its properties that he had previously overlooked. Besides, whereas in their normal state the testees tended to use an object outside the area of its links with other objects (only 5 out of 22 testees found answers including the object in question into uncomplicated structures), under hypnosis nearly all testees began to "improve" it, build complex structures using it as the basis or as a part (sometimes even an unimportant one) of some other construct. The answers of the testees to whom the "great man" image had been suggested were more unexpected and original, and had a very

interesting structure. Often, the testee would come up with an answer which to the experimenter seemed utterly absurd, but, asked to substantiate his opinion, would give a sensible and even logical explanation. A comparison between the reference group (ten people) and the group tested under hypnosis for the number of actualised properties of all three objects (the brush, the key, the scale) revealed that the persons in the latter group named nearly 2.5 times more properties than those in the control group (15 and 35). We have calculated the overall number of properties for the three objects since, having discovered a possible application of one object's property, they transferred it to the other objects (if that was possible). For instance, stating that the key could be used as an electricity conductor, one of the subjects suggested that the scale could be used similarly. Under hypnosis, such practices were seldom observed (2 out of 7 testees), since the image of "a great man" did not allow them to "repeat themselves", making this line of search uninteresting for the testee.

It is noteworthy that under hypnosis, the set of the properties put to use underwent changes, and that the old solutions were "rejected", while the number of answers remained stable. Initially, the natural supposition was that suggestion of an image under hypnosis would surely make the subject more active allowing him to give more answers, including those that had been discovered earlier. This, however, was not the case. The testee who had adopted the part of a "great man" found new properties and used them to devise new answers. This made it possible to advance the hypothesis that a "new vision" of old objects develops while actualisation of the old stereotype is replaced by "new thinking". The same picture was presented by the experiments involving comparison of concepts. In the series involving hypnosis the testees found hidden properties of objects and established links between them on the basis of scarcely possible properties. While in the normal state, the average number of the properties for which a similarity had been discovered was five, and distinction, 6.5, in the experiments involving hypnotic suggestion the figures were 10 and 12 respectively. The overall number of the properties actualised by the testees under hypnosis was 33, and by the reference group, 20 (70 per cent lower than under hypnosis).

The results of the experiment indicate that the testees to whom the image of a creative person had been suggested coped with the tasks much better. Subjecting ten adult testees who were not susceptible to hypnosis to the same experiments

produced the following results. In the task requiring finding uses for the objects, the average number of answers was eight, and the number of transfers from one category into another, six. In comparing objects for similarities and distinctions, the number of used properties was four, the overal number of answers, six in the former case, and five and six respectively in the latter case. This is somewhat lower than when testing the reference group without hypnosis. This fact may be found to support Crippner's hypothesis that creative people are more susceptible to hypnosis; however, this idea requires careful experimental substantiation.

Interesting data have been yielded by experiments involving actors. The initial number of answers they supplied when tested in their normal state substantially exceeded that received in the same series of experiments from the reference group (an average of 18 as against 11), which can probably be accounted for by the actors' greater creative potential. The number of properties they made use of was also higher than that employed by the reference group (12.5 against 9). The same is true of the test involving comparing notions (finding the points of resemblance, the average number of answers was 13, and of the properties used, 9; finding the dissimilarities, 15 and 9 respectively). However, even more interesting results were yielded by the series of experiments involving role-playing. In that case, just as in the series involving hypnosis, the greatest number of new answers were given (in finding usages for objects, 8, and in comparing notion, 7 and 5), but the number of properties that were used did not coincide (an average of two new properties in the usage-finding tests, and 1.5 in comparison-making ones.)

The reader should recall that under hypnosis, the average number of new properties in the first group of tests (those requiring finding usages for objects) was 7.5 (the overall number of new answers was 9), and in the series involving finding points of resemblance and dissimilarity, 5 and 5.5 (the difference in the number of answers in the hypnotic and the non-hypnotic series was 5 and 7 respectively), i.e., the increase in the number of new answers supplied by the testees under hypnosis and by the actors performing a role was produced by different causes. An actor who in the first series of experiments (where he did not play a part) thought of everything he possibly could and was faced with the need to come up with more answers, began to "re-process" the already discovered properties trying to use them in other possible situations. For

instance, having first said, when being tested as himself, that a brush could be used to comb one's hair, in the second series of experiments (in the role of a "great man") the testee said that it could also be used to "brush and tickle a cat". In the third series, the testee suggested that a key could be used to produce certain sounds (by knocking it against metal) and, after assuming role, that a possible use was "to create a good mood" by joining a number of keys in a bunch "to make them produce a pleasant melodious sound".

As noted, the hypnotised subjects' strategy was quite different. We see therefore that although more new answers were given in both cases (under hypnosis and in playing a part), the "quality" of the increase differed. To more vividly illustrate this, we have calculated a coefficient for both groups constituted by the ratio of the number of answers to the number of the properties employed. It turns out that whereas for the experimental group the value of the coefficient (1.2) was roughly the same under hypnosis and without it (which means that each property was matched by an average of one answer and that new answers were found primarily by discovering new properties), for the group of actors performing the role of a "great man" the coefficient rose sharply (4 for the usage-finding tests and 7 and 5 for comparison-making tests). Besides, another interesting distinction in the behaviour of the two groups was noted: all actors playing a part repeated their earlier answers or requested the experimenter to take them into account. It did not occur to a single one to do without them while, as we already know, this is precisely what all hypnotised testees did. Consequently, analysis of experimental data has shown that creative processes become more active under hypnosis when a certain type of image has been suggested, and that there is a difference in the character of answers between actors consciously playing a part and hypnotised testees who have been suggested a certain role.

When an active image has been suggested under hypnosis, creative processes, including verbal ones, may become much more lively. The very style of thinking changes. The testee acquires a "new vision" of familiar objects, the personality change produces a new strategy of thinking, the testee is no longer satisfied with isolated answers but builds a system of reasoning. The answers received from the testees playing a part are essentially different from the results yielded by testing hypnotised testees (in the deep phase of somnambulism). Hypnotised subjects, in fact, create "more profound" effects

than actors. Experiments have shown once again, that the method of active somnambulism, with an image suggested to the persons involved, may be used to experimentally change personality traits and to analyse the impact of personality traits on intellectual processes.

The difference of principle that has manifested itself between the results shown by professional actors and the principal group of testees in the state of active somnambulism, underscores the major distinctions between these two states even if they may appear superficially similar. The most striking differences manifested themselves in two areas, one of which had a paradoxical character. Hypnotised testees showed more artistic qualities in the state of active somnambulism than professional actors, who performed the tasks they had been given in a concentrated, calm and even somewhat languid manner. The hypnotised persons really "lived" the role they had been suggested. The general picture of their behaviour left the impression that the process of solving the tasks was, for them, a genuine act of creative thinking. Their behaviour was so impressive that was perceived as a creative response even outside the context of the test. The process of dealing with fairly banal tasks, as far as their content was concerned, gave them a chance to make original, even philosophical, logically complete and rounded generalisations. The second distinction has even more importance. It is the posthypnotic reaction of the testees who had performed a creative task, which in all cases was clearly manifested. All testees felt a surge of psychic energy which was, in some degree, an aftereffect of their work on the task under hypnosis. One of the testees wrote a poem, with the similarity between a steam engine and a steamship as the theme. Another, after two hypnotic sessions, reported that he "felt born anew, perceived the world in an entirely fresh way, much more vividly and colourfully". He felt elated, had an urge to work, to do creative things, to think. A person who had never even tried writing spent three days writing a piece which he enjoyed reading to his relatives and friends. The third testee, a research scientist, also stated that he was feeling extraordinarily well, experiencing a burst of creative energy and higher productivity. The fourth felt for several days that, "without any conscious effort, he perceived the ties and regularities in the development of things and individual objects". He was in "excellent form, wanted to work, and worked efficiently and well". The actors felt weary and irritated after the tests and did not display increased activity either during

or after the experiment. The suggestion of an image of a "real" personality paved the way for an eminently realistic reflection of the world in the context of actively matching the image that had been suggested. This research indicates the ways in which man's creative thinking can be regulated.

Thinking and regulation. In the process of communication, the results of one person's thought activity (knowledge) are passed on to another. This refers to both individually and collectively generated knowledge. The concept of assimilating collective experience is a major one describing man's individual psychic development. Knowledge (generalisations) may pertain to the object world (the world of other people), or to the very process of dealing with problems (the general methods of solution). The person communicating knowledge may be just helping the other person to assimilate collectively generated knowledge. For example, a teacher does not produce the concept of "perpendicular", he only communicates it to a pupil and helps organise the process of assimilating this concept. Assimilation of knowledge has a controversial effect. On the one hand, a person's thinking *acquires* a new means of the expansion of his capabilities, and on the other, he is *relieved* of the need to do independent thinking necessary to generate this knowledge (thinking continues only as an expression of activity when assimilating knowledge).

Here is a simple example of a game situation involving two partners. Fifteen matches are arranged on a table. The partners take turns removing one, two or three matches (such are the rules of the game). The person who takes the last match loses. There is a rule which guarantees victory to the person who begins (makes the first move) disclosing the number of matches that must be left on the table for the other player: 13, 9 or 5. If one of the partners knows the rule, he will display more effective work winning constantly, making no mistakes, and easily handling himself in each situation. However, he no longer does any thinking, it is enough for him to merely apply the rule with accuracy. Victory is secured by firmly memorising the rule, as a result of the formation of a mental skill, methods of intellectual work.

Psychological writings do not always draw a line between application of ready-made knowledge and refined mental skills, on the one hand, and original thinking, search, and generation of new knowledge, on the other. This obscures the distinctions, which have a significance of principle, between solution (by adults) of categories of arithmetical sums and, for instance,

puzzles. Mental skills may relate not only to solving a problem but also to the preliminary systematic examination of its conditions. Formation of mental skills (mental actions) is studied most thoroughly in the works of Pyotr Galperin and his school within the theory of step-by-step formation of psychic processes with preset properties.

In working on the problem of regulating another person's cognitive activity (its planned formation), it is necessary to remember that both cognitive activity and the work regulating it have a multitude of forms. Application of assimilated concepts, rules, logical devices and general cognitive methods by no means exhausts cognitive activity. What is more, application is not really thinking. The experience that has been assimilated is only a major prerequisite, condition of thinking, connected with its ultimate productivity in more ways than one (past experience may halt thinking). The current phrase, "formation of a mental action", has at least two meanings: a) formation of an action in the sense of "rehearsing", "refining", "perfecting" it; and b) formation in the sense of transition from ignorance of a certain mental action to first performance of this action. Let us consider the first aspect of the problem, since the other has been dealt with in detail in Chapters Three and Five. In working on the problem "thinking and regulation", it is necessary to make a clear distinction between external and internal regulation of activity. Both may be either voluntary or not. Emotional regulation of thought activity is an instance of internal involuntary regulation. Formation of affective traces by the experimenter's purposeful actions, which determine the effectiveness of later search for the principle of the solution and of independent goal-formation, is an example of external voluntary (purposeful) regulation of cognitive activity. External regulation must take due notice of internal regulation i.e., *self-regulation* of thought activity.

External regulation of another person's cognitive activity is an activity with its motives, individual goals and situation-conditioned operations to achieve them. For instance, the goals of regulating another person's cognitive activity may be "formation of cognitive motivation", "leading towards an independent solution", "formation of intellectual emotions", "securing an unerring fulfilment of unambiguously interpreted instructions". The ways of attaining individual goals may "negate" each other: in forming the operational aspect of thinking, the testee must be *informed* of the sequence of actions, whereas in forming cognitive motivation this sequence *must not be disclosed*, since

otherwise no problem situation will arise. Regulation may be executed in conformity with a pre-planned and fairly rigid programme or include solution of a mental problem by the one who is regulating the person's cognitive activity. The most complicated (and least examined) case is that of "problem regulation of problem training". The person who does the regulation tackles new thinking problems involved in the regulation of the other person's solution of new thinking problems. The problems of the first category are also associated with the study of the regulated subject's state and personality traits.

Psychological literature is discussing the correlation of "spontaneity" and "susceptibility to regulation" in the development of cognitive activity; sometimes the main achievement of regulated formation of cognitive activity is seen in the "expulsion of spontaneity". Actually, what should be analysed is the correlation of external and internal regulation of cognitive activity. The very fact of substantial expansion of the range of external regulation of cognitive activity is at present regarded as proved beyond any doubt. However, the following problem is still discussed: is it possible in principle to remove internal regulation of cognitive activity and thus have a case of purely external regulation? There is reason to give a negative reply to this question.

We already know that two components should be distinguished in the product of man's every action: a) that which has been provided for in the conscious goal and attained; b) that which has not been anticipated as part of the conscious goal. This also goes for actions regulating another person's cognitive activity, including educational and psychological influences. Even successful attainment of the goals of the most perfect psychological and educational influence does not imply that all objective consequences have been foreseen. This makes the changes in the subject's cognitive activity *relatively* independent of external regulatory influences. The absence of total dependence on the conscious influence of the other person conveys, specifically, the objective character of the features of cognitive activity itself. Internal regulation cannot be regarded as merely a temporary characteristic of cognitive activity. Naturally, this does not eliminate the need to look for ways to expand the possibilities of purposeful and conscious regulation of man's cognitive activity, including thinking, through external influences. Awareness of the actual correlation between external and internal regulation is important in assessing the types of experimental research into cognitive processes. Forming and

monitoring experiments are sometimes distinguished, and the forming experiment, seen as constructing processes with preset properties, are believed to be the main method of psychological analysis, while the monitoring experiment is considered second-rate. However, the acceptance of such a view leads to a number of theoretical difficulties. The thing is that, by definition, independent thinking cannot be rigid, stereotyped or fossilised, and therefore independent formation of new goals and subgoals constantly occurs not only in monitoring but also in forming experiments. One must also remember that each forming experiment requires information concerning the process's desirable properties formed through external influences, and this information can often be gleaned only by studying the already formed (albeit spontaneously) and successfully functioning forms of cognitive activity. This study is a source of generating goals of the subsequent regulating influences.

A special research examined independent goal-formation in the situation in which the testees were taught, on a planned basis, to solve game-playing tasks (the known game of Kalakh was used). It has been shown that a significant psychological characteristic of the planned (step-by-step) formation of a skill is the development of various types of independent goal-formation and their dynamic succession depending on the stage of skill acquisition. The experimenter differentiated between the following types of the testees' independent actions in evolving a new goal: (a) completely independent formation of intermediate goals, with an insufficiently specified requirement set to the final goal; (b) acceptance or rejection of externally set requirements, on the basis of which goals may be formed; (c) formation of concrete intermediate goals on the basis of not yet assimilated but already defined general intermediate requirements set to the final goal; (d) formation of gnostic goals not set by the experimenter; (e) transformation of generalised definitions of goals within the framework of an already evolved hierarchy of goals into concrete objectives. The process of goal-formation has certain characteristic features linked to the stages of skill acquisition being evolved. In the course of planned (step-by-step) formation of certain mental actions, the goal-formation processes of the (b), (c) and (d) type unfold. These mediate the assimilation of the new object-related content of the problem's material. In solving a problem by an earlier acquired method of orientating, goal-formation exists only as the transformation of ready-made cliches into concrete situational definitions of the goals [the

(e) type]. The goals formed by the testees are described not only for the degree of the testees' independence in generating them but also for their object-related content. In problem-solving in conformity with the orientation of the (c) type (both when acquiring new skills and when applying earlier formed ones), goals of a totally new type were advanced as compared to the conditions when combinational goal-formation was quite independent [the (a) type]. These new goals were associated with the orientation towards such properties of an object-related situation which before the training had not been identified as an independent category. Goal-formation as the formation of intermediate goals only under the conditions of unspecified final results should not be qualified as being at a lower level in respect to the other types of goal-formation. If the chance which exists in principle, of building the orientating basis of action along the (c) type proves unrealisable, this type of goal-formation becomes the only possible one as the foundation of the solution.

§ 5. Joint Activity and Thinking

The processes of interpersonal cognition, influencing each other, and exchanging messages (communication) are incorporated into joint practical activity. However, joint activity often involves solving intellectual problems, as is the case with scientific research or business management. In this case, thinking itself is joint, collective activity. This field is primarily the domain of social psychology, which should provide practical advice to researchers engaged in the study of joint thought activity. It is necessary to use the parameter of the level of *organisation* of the group, which acts as the subject in solving intellectual problems (diffuse group, collective). An individual's contribution to group decision-making may vary, e.g., he may be a leader. It becomes necessary to make a comparative analysis of the effectiveness of group and individual decisions. Relative effectiveness seems to be determined by the stage of problem-solving: thus, experienced inventors believe that at the earliest stages of seeking a new idea, individual search has advantages over team work, while the actual development of an idea can best be done collectively.

Joint thought activity may have a variety of forms. Among them is group *discussion*, which precedes the final solution and leads to it. A discussion may have the nature of a conference. Also employed is the method of organising discussion, in

accordance with which the group is divided into "generators of ideas" and "critics". A well-known method is the synectic one under which the most active group members are singled out whose goal is to formulate the opposite views as clearly as possible. Joint thought activity at times produces the phenomenon of "conformism" (adjusting one's opinion to that of the other group members). This has been intensively studied by social psychology. A change occurs in the nature of the risk inherent in the generated decisions as compared to individual ones. The ability to conduct an efficient group discussion is developed by the so-called socio-psychological training (teaching people to communicate). Joint thought activity is not only executed by a group. It also engenders changes in the group. One of such changes is the phenomenon of group polarisation. In the course of group discussion, the essence of conflicting opinions upheld by the various subgroups become nakedly clear and prompts their acceptance or rejection by the bulk of the group. More moderate opinions as it were wither away, and the more extreme ones become firmly fixed at one pole or the other.

In studying joint activity, one must differentiate between the forms of "collectivity": (a) when the participants in joint activity have only the goals in common, and (b) when motivation-sense formations are also common. Sense-formation and goal-formation are the structural factors of joint activity and indicators of its development standard. In it, common practical, gnostic and communicative goals are shaped.

Joint activity gives scope to the development of many aspects of goal-formation: generation of a single instruction (task), the requirement of "working together", the formation of a common goal through a juncture of individual goals, acceptance of the partner's definitions of intermediate goals as one's own goals, transformation of individual goal-formation processes into the processes of joint goal-formation, the processes of joint reconstruction and acceptance of the partners' goals on the basis of exchanging definitions of goals, observation of the results of the effort to attain them, and unverbalised characteristics of the goals.

One should remember that the division of thought activity into individual and joint is only conventional: even individual problem-solving incorporates the products of other people's thought activity; to a certain extent, it is always oriented at another person.

§ 6. Thinking in Dialogue with the Computer

Among the fairly new fields in the psychology of thinking is the study of thought activity mediated by computer programmes. These programmes, especially those involving dialogue, i.e., those which allow an exchange of messages in a language close to a natural one, can help exert influence on the processes of problem-solving by testees, study their various features and communicate with them. An ADVISER dialogue programme has been created. It is called so because its principal function is to give all kinds of advice to the person working on an intellectual problem. The object field was formed by the game of Kalakh, which is believed to be one of the oldest Oriental games. Games of all kinds have recently been widely used not only in the study of thinking but also for the creation of computer programmes. Generally speaking, a game presupposes setting and attaining a number of goals: 1) to win; 2) to choose a certain type of strategic task in order to promptly gain the final goal; 3) to find the tactical moves which would promote the solution of the strategic task. Each move is described through its relation to this hierarchy of goals.

The first Kalakh computer programmes were written in the context of research into the possibilities of computers in modelling natural intellect. Methods have been developed of studying independent thought activity of the testees appealing to the computer for advice in the regime of dialogue conducted in a language close to a natural one (in this case, Russian) in the process of the search for the best move in a game. A condition of the computer generating messages are the Kalakh programmes (a bloc of the so-called problem programmes) and the programmes organising personal dialogue with the computer. The existing methods of formalising the game make it possible to create sufficiently "strong" programmes which can outplay man. Therefore the information received from the ADVISER may, for instance, have concerned the game situation *after* the first 5-8 semi-moves. In conformity with the stated goals of the game, three categories of messages (advice) were developed, which made it possible to receive information about the result of the choice of a move, assessment of a move made by the testee or his opponent independently of the computer (I), information about the chances for realising the game's strategic goals (II) and information concerning the tactical devices employed in Kalakh (III). Here are examples of messages generated by the electronic ADVISER: "The best move is

from square 1", "evaluation of the opponent's move 022", "in your situation, it is possible to assemble the opponent's chips in your *kalakh*", "it is advisable not to move your own chips to the opponent's squares". In the second variant of the programme, the messages differed substantially: "at the depth you have chosen for analysis and at the designated square 6, the maximum number of chips in the *kalakh* is 15", or "at depth 4, the opponent can catch your chips twice".

Introduced into "dialogue" apart from the messages listed above, which were termed "basic", were special messages aimed at forming a positive attitude to the computer. The selection and application of computer messages was regulated by the testee himself. The time of sending inquiries to the computer was determined by the natural rhythm of the problem-solving process, the rhythm of communication. The opportunities for satisfying the cognitive urges arising in the process of solution were secured by a wide range of types of computer messages. This method also made use of the messages taking part in the organisation of the dialogue proper between man and the computer and arranging its rhythmical structure, the messages that allowed the person to formulate a correct question to the machine, and the messages exerting a positive impact on the testee's assessment of the regime of interaction with the computer and his own participation in the process of joint solution. The method made it possible to record the temporal structure of man's interaction with the computer, automatically to register the number of the testee's inquiries pertaining to all types of principal messages, and to analyse how often they were repeated, the sequence of the analysis of individual elements of the problem's conditions by means of the computer, the depth of the analysis and the testee's selectivity with reference to the different versions of the solution. Automatically recorded was the interaction (exchange of messages) between the computer and the testee. There was also a record of the results of the problem's solution and the use, or non-use, of the computer's advice, which has become possible thanks to the combination of the automated methods of research into thought activity with traditional ones, e.g., the method of recording verbal discourse. The electronic adviser allows the player to get additional information concerning both his own and the opponents' actions.

Experimental psychological research indicates that the ADVISER's involvement into the thought process may have different forms. The extent of the involvement is characterised

by the degree of correspondence between computer data and the content of intermediate and final goals. The extreme cases are complete and unconditional involvement and use of the computer data, and obvious non-use of these data.

Let us cite an example illustrating the testee's reasoning in working on one of the problems: "I'll take any field... № 6... Will the computer tell me how many chips I'll have at depth 5?" The experimenter: "Yes." "Then of course I'll take the first advice." In response to the first inquiry, the machine states that the testee will have 23 chips accumulated in the *kalakh*. This number is clearly insufficient for victory. The testee asks for advice again.

In the course of the experiments, the testees evolved additional goals, those of addressing the computer, which were not immediately oriented at solving the problem: goals aimed at getting information from the computer in the quickest and most efficient way, goals aimed at organising dialogue with the machine in a certain way, and goals aimed at additional assessment of the chosen square as the final result. If the testee's instruction imposed certain restrictions on the range of advice provided by the computer, or if he had no opportunity to check the machine's actions, this affected the procedural and productive aspects of activity: overall productivity fell to 44 per cent, the testee's ranges of inquiries became narrower, and negative subjective evaluations of both the advice and the computer arose. The electronic ADVISER gave the testee information concerning the situation which he himself could not get, and this sometimes gave rise to negative emotional evaluations. If the negative factors were overcome, the testee using his ADVISER, coped with more complicated problems and made a more thorough analysis of the problem's conditions.

The frequency of the testee's appeals to the ADVISER gives an idea of how intensively he needs and uses the computer data generated in the course of problem-solving. It is an indicator of the emergence of the cognitive urge. How pronounced this need may be is illustrated by the following figure: in dealing with one problem, the testee may appeal to the machine as many as 42 times. The scope of the search for solution is described by the number of situation elements examined by the person. The fullest scope of the examination includes 7 of his own and 7 of his opponents' squares viewed in a variety of interactions and contacts. As the depth of the solution increases, the full scope grows in geometrical progression. For

example, a problem solved at depth 5 requires (in case of complete examination) that 106,748 variants of links between all possible transformations of the initial situation are examined. This precludes the possibility of solving the task on the basis of "complete orientation". Most often, the players made an attempt to analyse the situation before appealing to the ADVISER, singling out individual elements of the problem's conditions and their characteristics, which are then tested by means of computer advice. When the testee has solved more than one problem, preliminary (before the first appeal to the computer) analysis may become substantially curtailed, and analysis of the squares on the basis of computer data may expand. Information received from the ADVISER is always correlated with the testees' independent forecasts, and the search either unfolds or is curtailed depending on the correlation between the forecasts and the actual results. Sometimes, no preliminary examination of the squares at all is made. In cases when the analysis of the problem is wholly based on computer data, the testees study and identify the properties of situation elements using one or two pieces of advice. This can help assess and compare the advantages and drawbacks of the square under analysis.

The electronic ADVISER supplies the player with data allowing him to act at greater depths than that ordinarily accessible to him. For this reason, it can be compared to the depth of mental analysis of the situation accessible to the testee. The ADVISER substantially expands man's capacity to forecast the various transformations of game situations (forecasting the consequences of one's own actions for a certain number of moves). The depth of the computer's calculation of the moves is regulated by the testee. The process of solution was marked by an increasing depth of the testee's own analysis, i.e., gradual transition from the use of data at the depth accessible to the testee's independent analysis (depth 2 and/or 3), to a greater depth, which cannot be reached by mental calculation of variants (depth 5-8). To solve the problem on the basis of data generated by the machine, the testee used new data to substantiate the final goal. The meaning of the final goal was formed under the impact of ready-made knowledge received from the ADVISER concerning the properties of the squares. The player's work together with the ADVISER was efficient only when he had a chance to control the ADVISER's actions.

The experiments made a comparison of two variants of the ADVISER programme. The first was oriented mainly at the

productive aspect of the problem's solution. The machine generated data which could be used only to check and compare one's own solution against machine-produced variants of the "best move". By their nature, the messages resembled obligatory instructions rather than advice. The information about the "threats" and "moves in the *kalakh*" was vague and unspecified. The second variant was geared to both the productive and procedural aspects of the solution, the data could be used at the stage of forming intermediate goals and their verification and correction. It turned out that work with each of the programmes had many points of difference. The testees who worked only with the first variant displayed a fairly low productivity of solutions (the best move was found only in 44 per cent of the cases). The use of the data was marked by rather varied forms of its inclusion in the search for solution: total refusal to appeal to the computer, occasional interruption of applications, partial (oblique) use and involvement of computer data as the final result of the solution. In solving one or a number of problems, the testees demonstrated a certain dynamics of the transition from one form of involvement of computer data to another. In the experiments using the second variant of the ADVISER programme, the overall productivity reached 90 per cent. Not a single testee refused to use computer information or even partially ignored it. The data were included into intermediate and final goals defined by the testee and the substantiation of the best move, and exercised an influence on the change in the orientation of cognitive activity. In employing the first variant of the *programmes*, the testees made fewer applications to the computer (1.4 application on the average), whereas in the second variant, the testees applied to the computer as many as 17 times. In the former case, the testees applied mostly (in 77.6 per cent of the cases) for mandatory instructions suggesting the best move, for numerical computer forecasts of their own squares' potential and of their own and the opponent's moves. Only in 22 per cent of the cases, the testees made inquiries pertaining to a generalised prospective evaluation of the game situation or asked for tactical recommendations. In using the second variant of the programmes, applications to the ADVISER were more varied and extensive in nature, with a higher percentage of use of all types of computer data. The number of applications to individual pieces of advice reached 47 per cent. Experiments indicate that excessively authoritarian instructions received from the ADVISER and their "inscrutability" to the testees, adversely affect the

productivity of the problem-solving process and the testee's potential for finding the best move, restrict his cognitive activity and compels the testees to negatively assess the use of ready-made computer data. The ADVISER's orientation at the procedural aspect of problem-solving is a positive factor making it possible to regulate the thought process and to substantially expand the testees' potentialities by making broad and full use of the possibilities offered by the machine.

Electronic ADVISERS are now used in management, planning, scientific research, teaching. The creation of dialogue system of the "person-computer" type oriented at the user without a knowledge of programming, is one of the basic trends in R & D in the field of automation of brain work. Laboratory experiments allow us to understand just what it means to be solving a problem jointly with the computer. It amounts to more than correctly formulating and feeding questions into the computer. It also includes psychological characteristics of the analysis of the content and meaning of the messages, a varying intensity of cognitive activity, and the users' subjective goals. The user's readiness noticeably affects the form of the computer's data involvement into the structure of problem-solving. The experiments substantiate the importance of the principle of maintaining and preserving man's maximum activity; its implementation makes it possible to increase productivity of labour, expand man's creative potential and eliminate the negative aspects of man's interaction with the computer. An important factor beneficial for shaping the user's overall attitude towards the computer as an "assistant" and "partner", is a certain arrangement of dialogue, the use in it of communicative remarks which liven up the interaction, and to a certain extent, alleviate the monotony and "intrusive" quality of the computer's questions. It also adds to the satisfaction received by the users from work with the computer. To secure the users' efficient work, dialogue must be flexible enough, so that they could use several types of questions formulated with due consideration of the goal-forming process, and to check the computer's answers by special inquiries. The rhythm of the interaction should be so set as to harmonise the dynamics of the computer's work with that of the user's thought activity. The structure of the dialogue must be designed to ensure the transition from extended and explanatory forms of the users' inquiries to the machine, into concise and compressed ones. The psychological requirements to the development and use of dialogue systems can be generally defined as follows: it is

necessary to take account of the qualitative aspect of the user's thought activity in the evaluation of the overall effectiveness of the dialogue system application; the psychological evaluation of the effectiveness should include a number of criteria determining the involvement of computer data into the users' goals, the chances for the expression and development of cognitive activity, a rhythmical arrangement of the temporal structure of the inquiries to the computer.

This method makes it possible to use man-computer dialogue for experimental psychological research into the thinking of the person participating in the dialogue. It is based on the examination of activity for the number of inquiries addressed by the person to the machine, the frequency of these inquiries, the selectivity of the examination of the conditions with the aid of computer information, the characteristics of the transformed situation checked against computer data, the person's control over problem-solving by the computer, evaluation of reliability of computer data and the temporal characteristic of the problem-solving process involving the computer. A comparative analysis has been made of the productivity of work in employing dialogue programmes whose orientation varied within a certain range. The method has made use of automated means of collecting, processing and accumulating the data which change the organisation of the research into the testee's thought activity as compared to the traditional methods, i.e., cut down the time needed to process the initial information and the amount of labour going into processing and analysing empirical data. The computer's positive influence, which manifests itself in the changes in thought activity, is possible only when a number of psychological principles are observed in organising the testees' thought activity: a liberal regime of interaction with the computer, consideration for the psychological characteristics of the goal-formation process, and the setting of the rhythm of communication. Neglect of any of these principles results in the computer exerting a negative impact upon the testees' activity.

The method under discussion has made it possible to make a comparative analysis of goal-formation in solving problems in dialogue with the computer and under the conditions of interpersonal communication. It was shown that the use of computer data qualitatively alters goal-formation processes, revealing entirely new aspects of object-related situations that would have remained hidden but for the computer, changing the object-related content and pattern of the goals of the

problem-solving process, expanding the zone and modifying the level of independent selective search.

A decision mediated by computer data is more efficient (from the point of view of productivity, the features of goal-formation and quantitative parameters of the interaction) than a decision unaided by the computer, a decision arrived at with the help of another person providing the same type of assistance, and a decision achieved on the basis of acquired skills.

It has also been demonstrated that the sequence of assimilating computer data and the scope of goal-formation are also affected by the changes in the situation of communication. Simultaneous actualisation of the attitude towards the computer and towards the experimenter facilitates comprehending the difference between the two levels of uncovering the properties of the object-related situation. In realising both aspects of the relationships, goal-formation is determined by the organisation of the testee's joint activity with the experimenter. This affects the formation of specific final strategic goals of the solution and advancement of certain relationships. The influence of communication on the use of computer data is traceable only in case of specific type of advice—generalised advice which outlines a new zone of analysis of the situation. In case of direct advice which does not imply changes in goal-formation, the changed situation in which advice has been received does not affect the nature of the solution. With reference to the computer, one must distinguish between a certain potential attitude to it which is present even before the experiment and in the absence of a computer and includes confidence or lack of it and an assessment of the computer's possibilities, and, on the other hand, the actual attitude, which has two more aspects: (a) subjective perception of the computer as a partner of sorts; and (b) an attitude to it as to a means of solution which must be mastered. The use of computer data and the restructuring of goal-formation is affected, above all, by the actual attitude towards the computer. A qualitative change in the verbal definition of goals in revealing a new level of properties of an object-related situation, is associated with the change in the functional role of image structures, as well as with the shaping of a new vision of the problem on the basis of the developing actual senses of computer data and the operational senses of the situation elements at a new and deeper level. When thought activity is directly regulated, goal-formation is not transformed to the

same extent as in dialogue with the computer during which indirect regulation is exercised.

Another method of research into goal-formation involving dialogue with the computer has been evolved. The testees were required to generate possible goals with regard to well-known objects. The method of the experiment included a preliminary study of the production of possible goals on the basis of information that has been received, working out the means of additional assistance to be rendered to the testees in the situation of using computer data and realising these means through computer programmes. The starting point was the supposition that one of the components constituting the process of producing possible goals involved in the study of the object is revealing the properties of this object, and that the restrictions reducing the effectiveness of this process have a similar character. The testees taking part in the preliminary series of experiments were instructed to name the maximum number of (a) properties of a given object; (b) unique properties of this object; (c) possible goals to be set in the process of its examination; (d) original possible goals. The experimenters recorded the products of the testees' activity, the time they took to perform the task, refusals to continue work, the testee's account of his own actions, thinking out loud and spontaneous remarks, the GSR and the pulse. Also recorded was the sequence of the computer's replies.

The method makes use of the following modes of computer work: 1) "the original property": the computer randomly selects from its memory the least common property, and the testee is required to define a possible goal using it; 2) "property": the same procedure as in mode 1, but the selected property has been named in not less than half of the cases; 3) "combination": the testee makes inquiries concerning the properties and the computer selects a combination of properties with due account for the frequency of their occurrence; 4) "problem": the computer produces a definition of a possible goal of the object's investigation, and the testee is required to define another possible goal. A comparative evaluation of the effectiveness of the goal-formation process in using the computer and working independently, was reached by a poll of experts and the generalised procedure of statistical processing of the data received. In the principal series of experiments 45 persons were involved, who first produced possible goals independently, and then (after the third refusal to go on with this work), were assisted by the computer. The method

provided for the testees' free choice of the "dialogue mode" of interaction with the computer. The programmes were written for the ES-1020 computer in the PL-1 language. The results were as follows. Comparative analysis of productivity in the cases of independent and computer-assisted work has shown that the use of computers has allowed each of the testees to increase the number of revealed goals by an average of 152 per cent; the overall number of general lines in the examination of the object, by 60 per cent; and the number of goals not connected with the object's customary application, by 160 per cent. In 60 per cent of the cases, the originality of the goals produced jointly with the computer received much higher grades than those generated independently. Working with the computer, not a single testee (as distinct from the preliminary experiments) built a hierarchy of general goals. The boundaries of traditional ideas about the object under examination were substantially extended. This was witnessed by a considerable increase in the number of goals not associated with the customary usages of the object in question. Under the conditions of dialogue, the testee concentrated more on the process of generating goals than on their critical evaluation. At the same time, the chance to "shift the responsibility" to the computer could promote the formation of superficial and even meaningless goals. The selective nature of the testee's use of computer assistance is determined by how prominent the testee's cognitive needs are, his subjective assessment of the complexity and success of the activity under a given programme, and the subjective assessment of the possibility to retain the "leading role" and a sufficient measure of independence in forming the goals.

The experiments have confirmed that it is possible to *regulate* goal-formation in the situation of computer-person dialogue by influencing man's motivational sphere. The overwhelming majority of testees evolved the "motive of competition with the computer". Its stable presence produced a substantial increase in the number of new original solutions of the experimental problem. The testees worked out a more complicated system of goals linked with making the task more specific, with direct communication with the experimenter and computer-mediated communication with the programmer and other testees. Using information about the testee's emotional state to regulate goal-formation, it has been possible to eliminate refusals to work with the computer. This used to occur in preceding series due to a sharp dissonance between the testee's

subjective assessment of the result of his activity and the computer's subsequent reply. It has thus been possible to preserve longer the positive effects of motivation (the motive of "competition with the computer" arose more frequently and was less frequently disrupted, the phenomenon of overmotivation did not take place); to attain a stronger positive emotional attitude to the work on the part of the testees. It has been shown that despite the psychological ambiguity of the vegetative parameters, they can be used to improve the methods of regulating goal-formation with the aid of computers, specifically, to coordinate the computer's replies with subjective assessments of the originality of the products of activity or to imitate such coordination when the computer's "intellectual" potential proves inadequate; to exercise control over the effects produced on the testee's motivational sphere. In dialogue with the computer, this makes it possible to prevent potential disorganisation of the testee's work and regulate the goal-formation process more flexibly.

This method may be used to analyse non-formalised processes of goal-formation and their regulation in conducting dialogue with the computer. The means of regulating goal-formation in the course of such dialogue make it possible to extend the opportunities for man's creative activity. This finds expression both in the increase in the overall number of goals that have been defined, and in a higher degree of their originality. The changes in the goal-formation processes can be effected both by using the computer for the purpose of mediating the interaction between the testees, and by using the computer as a "partner" whose selectivity during problem-solving is regulated by the experimenter. Dialogue with the computer extended possibilities for regulating productive processes by forming the motive of competition through (a) a more flexible individualised choice of the "competitor", with the computer performing this function; (b) executing control over the emergence of situations of "saturation" and "over-motivation". The objective data concerning the vegetative indicators of emotional activation may be used to regulate goal-formation and to enhance the efficiency of such regulation with the help of the computer. When computers are used to regulate creative processes, it appears expedient to work out dialogue modes possessing a certain degree of freedom. This would allow the user to independently regulate the conditions of his activity in dialogue with the computer.

Chapter Seven

THINKING AND KNOWLEDGE

§ 1. The Principle of the Unity of Communication and Generalisation

As Lev Vygotsky aptly observed, communication based on rational understanding and intentional transmission of thoughts and emotional experiences necessarily requires a certain system of means, whose prototype was, is and will always be human speech originating in the need for communication in the process of labour. Genetically preceding communication is a process termed contagion based on mutual perception by the organisms of expressive movements. Some content or other is communicated to another person only by relating it to a definite class, which requires *generalisation.* Communication necessarily implies generalisation, the development of verbal meanings. The higher forms of psychological communication, typical only of man, are made possible by the fact that man reflects reality in a generalised form through thinking. On the other hand, generalisation becomes possible as communication develops. For instance, to convey my state to another person, I must put a name to it, i.e., refer it to a class of states understandable to my interlocutor (to generalise). The meaning of a word is the unity of communication and thinking.

The main path towards comprehending the nature of *verbal thinking* is a study of the development, functioning and movement of generalisations (meanings of words). The meaning of a word develops not only ontogenetically and historically but functionally as well. Vygotsky interpreted the process of thinking as progressing from the initial and vaguest moment at which a thought originates until its completion in a verbal definition. The very progress from the thought to the word is development: the thought is not expressed through the word but occurs in and through the word. Each thought is solving a problem. The principal purpose of the analysis of the movement from the thought to the word is a study of the phases of

this process, making distinctions between the levels through which the thought that is embodied in the word, passes. Dealing with the functioning of developed thought, it is necessary to reckon with the lack of coincidence between the semantic and the physical aspects of speech, for instance, between the grammatical and the psychological subject and predicate. In the same phrase, for example, "The clock has toppled over", the part of psychological predicate may belong to either the noun or the verb. The latter is the case when the meaning of the phrase may be conveyed as follows, "What has toppled over is a clock". A special plane of analysis is inner speech, which has been examined through the analysis of the so-called egocentric speech. This type of speech is marked by brevity, predicative character and phonetic reduction.

Inner speech is interpreted as communication with oneself, which is another manifestation of the principle of the unity of communication and generalisation. Three major features of the semantic aspect of inner speech have been distinguished: 1. The sense of a word dominates over its meaning, the latter being only "a block in the structure of sense". In the context of the well-known fable about the ant and the grasshopper, the verb "go dancing" assumes a broader intellectual and affective sense ("enjoy yourself" and "perish"). Under the impact of the context, the word may come to mean more or less than its actual meaning (the signification either expands or narrows down). The meaning of the word is inexhaustible, as the number of contexts is inexhaustible. 2. Agglutination, an asyntactic "cohesion" of words. 3. The senses of the words, being broader and more dynamic than their meaning, are governed by other laws of unification and fusion than those that can be observed when meanings unite and fuse. The meanings, as it were, flow into one another.

The unity of thinking and speech does not mean identity: the units of thinking and speech do not coincide. That which is simultaneous in thinking is successive in speech. Meaning mediates the thought on its way towards verbal definition. A special aspect of analysis is analysis of the motivating sphere. Comprehending a person's speech without comprehending his motive, that for the sake of which a thought is expressed, is incomplete comprehension. The evolution of verbal thinking should be understood in the following way: from the motive generating a thought to defining the thought, to mediating it in the inner word, then in the meanings of external words, and, finally, in words.

The problem of generalisations, concepts, meanings and knowledge is a classic one. Indeed, thinking is generalised reflection of reality, and this is what makes it different from perception. Knowledge (generalisations, meanings) have a dual role to play: (a) as products of thought activity (through thinking, man generates new knowledge); (b) as tools, means of thought activity (available knowledge makes it possible to register new properties of an object and new relationships within this object, to probe deeper into what is being cognised). Knowledge (generalisations, meanings) may also have a dual form of existence, as a component of individual psyche and as a component of social, i.e., supraindividual experience. It is for this reason that subjectively new knowledge (new for a concrete individual) may have entirely different sources. In one case, the individual receives ready-made knowledge, and in the other, generates it independently. In the latter case, two variants are possible. Either the piece of knowledge generated by the individual had already existed in social experience or the experience of a group (this is the state of affairs conveyed by the phrases "to discover America", to "invent a bicycle"), or is entirely new with respect to the social experience (genuine discoveries). A specific case is the one in which the testee must evolve, as new to him, a piece of knowledge that the experimenter had created (experiments involving the formation of "artificial" concepts). Dealing with the formation of new generalisations (including generalised mental acts), a distinction is not always drawn between independent formation of new generalisations and prearranged assimilation of ready-made, socially formed generalisations.

Independent thinking may unfold in each of the above-mentioned situations but, naturally enough, to different degrees. They are most pronounced when new generalisations are generated and are least pronounced when already evolved generalisations are formed. The multiplicity of the types of generalisations corresponds to the multiplicity of the types of thinking (active, image, verbal). Let us consider in more detail the generalisations that are associated with the level of *verbal generalisation.*

§ 2. Definition and Comparison of Concepts

In order to find out which type of generalisations a given person has mastered, a variety of methods have been employed. Let us look at the method of defining concepts. The testees

were given a word or shown an object and were asked to give a definition, to answer the question: "What is this?", e.g., "What is a trolley-bus?" One testee may say quickly: "A kind of public transport"; another, "A thing in which one rides". In the first case, the class of objects is registered, i.e., logical relationships between a class of objects and its representative. In the second case, only the object's function is pointed out. Thus, different kinds of knowledge are displayed (reproduced) by the testees in answering the question. In the case when the testee mentions just the function, it is expedient to repeat the instruction asking for a definition ("give a more precise definition"). Having done some thinking, several testees come up with a developed logical definition. This may mean that they have not possessed a ready-made definition but evolved it fairly easily through additional mental work. Other testees find it impossible to go beyond the boundaries of a purely functional definition of concepts; however, attempts to give such a definition may also give concrete expression to their mental search.

This method has made it possible to single out two classes of concepts: scientific concepts and common sense, or daily, ones. The former, which are usually assimilated in the course of systematic studies, lend themselves easily to verbal definition but may not always be applied correctly. The latter, on the contrary, are easily applicable in the course of practical activity but are not always easy to formulate verbally. The method of definition not only makes it possible to register ready-made knowledge but also to analyse the manifestations of independent thinking. Common-sense (empirical) generalisations can, in turn, be subdivided into two classes: those which are generated independently and evolved throughout man's life, and those which are obtained from other people in the course of joint activity, but in conditions when the very process of assimilation is not strictly controlled (a situation when assimilation of commonsense concepts is rigidly controlled, "rehearsed", is possible in theory). For instance, the generalisation "heavy objects sink" is formed long before a person starts doing physics at school. The term "common-sense concepts" is not strictly scientific, since generalisations do not always have the status of concepts proper; rather, one may speak about a specific type of meanings of words.

Researchers working in pedagogic psychology sometimes tend to underestimate the significance of commonsense concepts. Indeed, it is fairly easy to demonstrate that the studies

of a pupil who has assimilated scientific concepts are more efficient than of a pupil who has not. However, the point is that so far, large areas of life have not yet been explored by science, with reference to them, scientific generalisations have not been formed, and we have to act on the basis of commonsense concepts ("worldly wisdom"). Besides, in scientific research and technical design, empirical generalisations may become the source, the breeding ground out of which primary hypotheses sprout. If we "cut off" this level of thinking (i.e., empirical generalisations) which appears so imperfect, we may nip in the bud the most important link in the process of thinking, the formation of new hypotheses. It is essential to make the best possible use of, to fuse the scientific and commonsense concepts in man's thinking, not to try and replace one by the other. Psychological literature has traditionally posed the problem of commonsense and scientific concepts with respect to child thinking. However, counterparts of commonsense concepts are present in the adults' thinking as well. Thus, it is difficult enough to come up with a universally accepted definition of science, including psychology, which is often mixed up with psychiatry. Nevertheless, science exists and marches on.

Psychological experiments make a wide use of the method which requires that the testee compare thoroughly familiar objects. For instance, he is asked to say what a chair and a table have in common. The answer "They are both pieces of furniture" indicates that the testee is capable of conceptual generalising, while the answer "well, uh, those which are at home..." shows that more concrete situational generalisations predominate. In this case, too, it is important to repeat the instruction to make sure that the testee is unable to produce another definition. The repeated requirement that common (or distinguishing) features of objects be named, especially when supported by the request to name as many of such properties as possible, or to name original properties, encourages independent thinking. The same end is served by increasing the complexity of the problem by confronting the testees with concepts (objects) which are not easy to compare.

In the course of experimental research involving 80 adults, they were asked to find common features in the following pairs of objects: copper—gold; sparrow—nightingale; sun—earth; cat—mouse; bus—tram; plate—boat. Taken into account were the number of the features used and the share of the most frequently used feature. The overall number of the properties

used was 9, 13, 11, 14, 9, 23, and the share of the most common property, 60, 59, 64, 54, 70, 16 per cent for each pair respectively. The number of properties differed substantially depending on whether the comparison was easy or difficult (the last pair): from 9 to 14 in the first case, and 23 in the second. The number of properties singled out can serve as a generalised indicator of the scope of the thought process, which is also borne out by a more equal distribution of the frequency of use. In a special series, the testees were instructed "to be as original as possible". The instruction did not provide concrete criteria to be used in comparing the concepts, yet it produced substantial changes in the progress of thought activity: the number of properties used increased, and peaks in the distribution of the frequency of use disappeared. For instance, in comparing copper and gold, the number of properties used grew from 9 to 26, while the share of the most common property dropped from 60 to 15 per cent, i.e., the indices approached those typical of the pairs that were not easy to compare.

It is clear that the instruction "to be original" changed the testee's attitude to the task, thus encouraging independent thinking in the experiment involving comparisons of concepts. The difficulties presented by comparing two pairs of concepts were also intentionally engendered by, as it were, engineering a clash between the two tendencies that manifested themselves in the course of problem-solving. For example, the task is to compare "man and horse". A farmer views these two objects as a certain unity that evolves in the course of agricultural labour, and this interpretation may prevail over the more abstract, categorial classification (animate creatures). The presence or absence of such prevalence, the possibility of switching over from one type of generalisation to another, is revealed by the comparison method.

§3. Classification of Objects. Semantic Fields

Another method frequently used in experimental psychological research is asking the testee to classify the objects presented to him (their representations or the concepts designating them). A version of this method, which has come to be known as "the fourth is one too many", is as follows. The testee is given four objects, three of which are easy to unite in a group on the conceptual, and other three, on the situational basis. He is requested to bring together the three objects

which go with one another and to eliminate the fourth, discordant one. Lack of precision in the instruction is part of this method, for the experimenter wants to discover which of the possible criteria will be selected by the testee. Consider the following example. The testee is shown a picture of four objects, an axe, a saw, a spade and a log. At least two variants are possible in this situation: a) an axe, a saw, and a spade—tools; and b) an axe, a saw, and a log—objects used in making firewood. The prevalence of situational or conceptual generalisations and the ability to switch from one to the other, characterise the testee's intellectual activity. It is also possible to unite objects on the basis of unusual and seemingly strange but formally correct parameters: the words axe, saw and spade all have the letter "a" in them. Widely used is the method of free classification, under which the testees are offered several dozens of objects or their representations: animals, vehicles, members of various professions and trades. The testee is requested to arrange the picture cards into groups bringing together those which "suit each other best". Here, the instruction is also deliberately vague, and the testee's independent selection of the basis for classification is analysed. Fulfilling the instruction, the testee is then asked to expand the groups by uniting them. The greater the scope of the search for a new basis of classification, the more pronounced independent thinking is revealed in the experiments.

More complicated methods involve a study of entire systems of links which are formed between individual generalisations,—individual concepts and individual meanings. This trend is sometimes called a research into semantic fields, or subjective semantics. It is a psychological axiom that given the same object-orientation, the meaning of a word may not be the same, and it is therefore a major goal of psychological analysis of verbal thinking to look for approaches to the description of those individual, subjective meanings (generalisations) which are concealed behind the word in each concrete individual and which need not coincide with the meaning to be found in the dictionary. One of the methods is that of the so-called association experiment, which boils down to the following: the experimenter names words out of a list drawn up in advance. The testee is asked "to respond as quickly as possible with the first word that comes to mind". A condition of the experiment is relaxation, readiness to name precisely the word that first comes to mind. Research has shown that certain answers crop up more often than others. For instance, a

frequent response to "poet" is "Pushkin"; to "table"—"chair", to "fruit"—"apple". The responses given by each individual testee are compared to those that had earlier been given by a representative group. The comparison shows whether a person tends to think in terms of typical, stereotyped bonds, or deviates from stereotypes and displays a tendency to establish unusual, original links. Experiments of this kind held in different parts of the USSR indicated a dependence of the semantic bonds emerging in man's psyche on the way of life and nature of occupation. Association experiment makes it possible to penetrate, to some extent, the system of semantic bonds formed by a given individual.

The methods of defining, comparing, and classifying concepts and forming associations are related to the registration of arbitrarily controlled replies (verbal). However, psychology has also developed methods of studying semantic links, methods based on recording the organism's involuntary responses (changes in the skin resistance, vascular reactions), which are components of its defence or orientating reaction, making it possible to get information concerning semantic bonds without using the testee's report. A classic research was conducted by Alexander Luria and Olga Vinogradova, which has greatly affected the development of psycholinguistics. Adult testees were offered a series of words, after one of which, "a violin", the testee was subjected to a light electric shock that produced an involuntary defence reaction (constriction of blood vessels in the fingers of one hand and in the forehead). In addition to the word after which the shock occurred, a defence reaction was later triggered off by a number of other words (the generalisation phenomenon), to be more precise, words that were semantically close to "violin": "a string", "a bow", "a mandolin". Another group of words gave rise to an orientating reaction (also involuntary), which made itself felt in the constriction of blood vessels in the fingers and dilation of the vessels on the forehead. This group included words whose meanings were more distant from the "critical" word: "accordion", "drum", (non-string musical instruments), "concert", "sonata" (words associated with music). The rest of the words did not produce either a defence or an orientating reaction ("neutral" words). The experiment indicates that surrounding each word are, so to speak, three semantic zones: a near, distant, and neutral. In other words, semantic links have a definite structure. These structures are not realised by the testees and change as their overall functional state changes (for

instance, when a person is tired). As distinct from the method of association experiment, this method permits an objective analysis of the individual semantic structure. The possibilities of this method are far from exhausted in studying the procedural aspect of the changes (restructuring) that occur in the semantic structures in the course of problem-solving and that make solution possible.

Another approach that is being rapidly advanced involves scaling. Here is an example of this type of research, which modified the method of semantic differential introduced by Charles E. Osgood. Experimental material consisted of eight cards with silhouettes of an arbitrarily modified circle, and a number of scales, each limited by opposite terms designating both the object's properties (physical and mechanical) and emotional judgements. One of the scales made use of the following pairs of terms: light—heavy, hard—soft, kind—vicious, stupid—clever, active—passive. The testees received the following instruction: "You will be given cards with scales on them, and pictures will be shown to you in succession. Your task is to place each picture either on the right or the left end of the scale as you see fit." It turned out that, on the basis of groups of data, a number of stable properties could be singled out for each picture. One picture was described as "light, kind, very clean, very cold, young, clever, almost quiet, nice, almost active, sweet, daring", and another, as "loud, swift, sated, almost active, almost bitter, strong". Experiments of this type reveal certain recurring patterns of interpretation of observed objects. Deviations from these patterns can provide information about individual systems of meanings. These meanings are subjected to intensive study in the context of psychosemantics.

§4. Assimilation of Ready-Made Knowledge and Contextual Meanings

A study of the processes in the course of which new concepts are being assimilated is an important part of psychological science. Supraindividual meanings, concepts are only gradually assimilated by the individual in ontogenesis. One must remember that the successes attained through the use of the forming experiment should not lead one to underestimate other methods employed in the study of thinking. The point is that the area within which this method may be applied is not boundless, since problems of such complexity can always be offered with

respect to which it would prove practically inapplicable. For instance, the list of properties to operate with may be too long, or it may be unknown to the instructor. However, this is not all. Recent research has shown that even when a person evolves a certain concept or skill following a rigid pattern, he still engages in independent mental activity, which is expressed in interpreting the situation of psychological-pedagogic research, and independent formation of additional goals that have not been set by the experimenter. A concept assimilated through thoroughly rehearsed procedures may enter into a variety of relationships with previously acquired knowledge. In order to understand what happens as a result of planned formation of concepts (generalisations) and outside this process, it is necessary to combine forming and diagnostic methods of research. Assimilation of ready-made knowledge paves the way for the development of "intellectual consumerism".

A study of generalisations, meanings and concepts traditionally includes definition of the stages they pass through in the person's psyche. However, another route is possible: to form in advance an idea of what the concept should be like, single out its properties, and then not merely communicate it to another person but make sure that it is assimilated fully and adequately. This approach is being successfully developed by Pyotr Galperin and his pupils. At the early stage of development of this trend, researchers proceeded from the numerous facts, cited in literature, testifying that schoolchildren's knowledge of certain things does not always live up to the scientific concepts of these things, which the children were in fact supposed to assimilate (e.g., instead of the concepts of "slave" they used that of a man in chains, did not recognise a perpendicular when it was turned by 90°). The question was posed: is it necessary for a person to be at first exposed to imperfect (as compared to scientific concepts) generalisations before he has assimilated a perfect generalisation (i.e., concept)? The answer was clear enough: no, it is not. A special educational procedure has been worked out ("stepwise formation") which incorporated singling out the list of properties of a given concept, and their testing and verification. As a result, verifying whether the presented picture corresponded to a given concept was free of error. At present, it is considered proven that the formation of concepts and logical methods, the brand of knowledge relating not to the object but the procedure of its transformation, can be purposefully controlled.

Contextual meanings. The word, with which verbal thinking operates and which is essential to it, usually has a number of meanings, some of which are registered in dictionaries and some of which are not recorded at all (jargon, for example). Therefore, a specific aspect of the study of verbal thinking is to understand and analyse the process in the course of which one meaning is selected from a multitude of existing and possible ones. This actual individual meaning is contextual.

A wealth of material having to do with the dynamics of contextual meanings is provided by the manifestations of man's complex mental work which is known as wit. A witty remark usually illustrates the subtle dynamics of the transition from one context to another. Here is an example. A customer in a restaurant asked a waiter, "Do the musicians play to order?" Receiving an affirmative reply, he said: "Here is a pound, let them play poker." The context of the remark and of the situation on the whole actualises the same meaning of the word "play". It is known that playing musical instruments is musician's job. It is also known that apart from their basic repertoire, musicians playing in restaurants often perform music ordered by the customers for an additional fee. However, this is not always so, and therefore, the question "Do musicians play to order?" presupposes selecting one of two possible answers: 1) "Yes, they do", or 2) "No, they do not". However, it is possible to play things other than musical instruments: "to play football", "to play with fire", "to play poker". There is nothing unusual in the last combination of words *per se,* but in the context of the situation described above, this meaning of the word is disguised by the meaning that is imposed by the situation. The unexpectedness of the transition to a disguised, latent, concealed meaning is a characteristic of wit. As we sometimes discover hidden, disguised properties of things, similarly we find out that at the level of meanings, we can use a word in a new way depending on the situation which actualises its other, traditional meaning.

§5. A Study of the Types of Generalisations and the Processes of Forming Generalisations

Psychological science has clearly established the following: the same word may contain different systems of meanings, a word's reference to the object and its meaning may not coincide. The meaning of the word "table" will not be the

same for a carpenter and a waiter. Verbal thinking is usually contrasted against visual-image and visual-operational thinking, but it is not homogeneous itself. The types (or levels) of verbal thinking are characterised by the types of generalisations contained in the word. The most primitive generalisation is bringing together, grouping objects on the basis of an individual, random feature, for instance, "a crowd of gapers". These are *syncretic* combinations. A more complicated type is the *integrating* generalisation. For example, the word "quack" is used to designate a duck ("It quacks") and all water fowl (which swim like ducks). The most complex type of generalisation is that in which a distinct line is drawn between specific and generic characteristics, incorporating the object into a certain conceptual system. In the case cited above, objects are grouped along different (a specific and a generic) principles ("to quack" and "to swim"). It should be again stressed that integrating generalisations (as well as the syncretic) are represented at all levels of man's intellectual activity, irrespective of its complexity.

Should we analyse the structure of the psychological science and compare the definitions of its branches and sections, it leaps to the eye that they are singled out (and, consequently, united into a whole) along different principles. Science is classified into branches not along the conceptual principle but along a principle that lies in between the syncretic and the integrating generalisation. This makes itself felt, first, in the attempts to turn "a branch" into "a science". Thus, engineering psychology is defined as a science of the information interaction between man and machinery; psychophysiology—as a science of the neuron mechanisms of psychic processes and states. From a science that, like all the others, is subdivided into branches, psychology has turned into a collection of sciences loosely linked up by such characteristics as "developed at the same research centre". Elements of the integrating character of generalisations also operate through the fact that studies of individual occupations cease to be branches and become sciences: for instance, "aviation psychology" is sometimes defined as a science and not a branch of industrial psychology. Some branches of psychological science are singled out on the basis of their links with an object-related field, others, on the basis of the type of the tasks tackled by the researchers. In each person's daily existence, it is possible to find a zone in which he classifies the objects on the basis of integrating generalisations. Obviously, packing for travel, most people do

not proceed from the conceptual basis when putting together the things they are going to take with them.

These types of generalisations have been subjected to special study. Researchers have formed a number of theoretical postulates which can be reduced to the following: the *process* of forming new concepts is of great importance, and the work should not be confined to studying ready-made concepts. In the course of the experiment, the testee should *gradually* construct a new concept (the genetic-synthetic method of research). One must analyse the process of the *word acquiring* a *meaning*. In thinking and acting, generation of concepts represents a means of attaining certain goals (generation of concepts as a condition of carrying out the task). The principal problem posed by the process of the formation of concepts, and of purposeful activity at large, is that of *means* with the help of which certain purposeful activity is performed.

Lev Vygotsky concentrated primarily on identifying the types of generalisations, but his method of forming artificial concepts may be used to analyse the procedural aspect of generalisations. The works of J.S. Bruner and his co-workers consider thought activity aimed at classifying objects as a series of the subject's solutions or test forecasts concerning the objects' properties. Attainment of solutions and their verification provide information, changing the number of hypotheses concerning the class that is being looked for. The sequence of the testee's solutions makes up the strategy that embodies certain goals: a) to build up to a maximum the information obtained from each individual solution; b) to contain the cognitive tension within certain boundaries; c) to regulate the various forms of the risk of failure to obtain information. Strategy is evaluated on the basis of these indicators whether the testee is aware of it or not. The changes in the strategy are described in connection with the changes in the problem's requirements. All this makes it possible to penetrate the very process of classification and go beyond the boundaries of merely stating its success or failure.

In psychologically analysing thinking as the process of forming generalisations, one must take into account the objectively indefinite character of the conditions of the problems and of the features that can be verified (and, consequently, the information value of their verification). It is also necessary to single out the lack of subjective definiteness of the problem's conditions and the subjective information value of individual research. The relationship between the

objective and the subjective lack of precision, the objective and the subjective information value constitute a major aspect of the psychological characteristic of thought activity. The process of solving an intellectual problem amounts to overcoming the initial lack of definitiveness in the conditions, an active selection of information which comes in as a result of the subject's own actions. Thought activity is marked by selectivity which manifests itself, specifically, in lack of coincidence between the objective and the subjective information value, the objective and the subjective lack of definitiveness. The same generalisation is formed as a result of differently organised research actions on the basis of different selective orientation not only in the object-related but also in the statistical field. This "prehistory" of an independently formed generalisation constitutes a part of its psychological characteristic (for instance, a generalisation built on the basis of minimally necessary data, and the same generalisation formed on the basis of excess data).

Chapter Eight

THINKING, THE SUBJECT, SELF-AWARENESS

§1. The Thinking Personality

The thinking is done not by thinking but by the person. Psychologists are fond of reiterating this phrase, and with good reason. Motives that are subjectively experienced as drives and wishes are a condition of man's mental work, without which, thinking simply does not "switch on". What then is the "personality" that is doing the thinking? It is not a naturally formed entity. It emerges in the process of joint labour which implies the use and production of various objects and tools, communication among people, certain relations among them. The level of personality development is characterised by the degree of social significance (i.e., significance for others) of this personality's life work that breaks down fossilised stereotypes. The core of the personality is its motives and its attitude to the world and to oneself. Variability of attitudes has been correctly described as their intellectualisation.

The tasks tackled by man have certain social and individual significance determined by their relation to social and individual needs. Obviously, the social significance of a puzzle will be incomparably smaller than that of, say, "finding a cure for cancer". One may also speak about group significance of certain tasks. For instance, the target "to hide when eating" is of utmost significance for a certain tribe of South American Indians. The ideal case (both for the personality and society) is when the social significance of a task and its personal significance are equal. The worst case is when the great personal significance of a task clashes with society's interests. There is a range of tasks that are more or less a matter of indifference to society but have high significance for concrete personalities (for instance, collecting matchboxes). When the point at issue is a task with a high degree of social

significance, its acceptance signifies actualisation of the personality's stable motives. Private situational motives may also become actualised. The puzzle used in Chapter Two does not possess great scientific significance, but under the given conditions may arouse an interest that supersedes all else. If we know a person's stable motives, we may predict which type of task he will tackle most willingly. Conversely, when we know which tasks a person prefers, we can surmise what his motives are.

As stated in Chapter Two, problems may be described by the "solvability-insolvability" parameter, which is assessed and reassessed by the testees either correctly or not. When the problem is unsolvable but this is not immediately apparent, a person tackling it develops a state of frustration (anger). Imagine a problem that has two solutions. You are asking a friend to solve it. Finding the first solution, you request him to find the other, which he does. Now tell him to find a third solution (which is actually non-existent). Encourage him, put some pressure on him if need be, so that he spends an hour or two looking for solution. If he starts to get angry with you and with everything around him, don't be surprised: according to the research executed by Tamara Dembo working within Kurt Lewin's school, this is only to be expected. This research has identified two types of obstacles on the path to solution: the barriers preventing one from attaining the goal (material objects, the problem's complexity, or the testee's lack of ability), and the barriers that prevent the testee from reducing the tension by leaving the field, i.e., by refusing to deal with the task. The latter type covers the totality of relations between the person who has offered a problem and the person who has taken it up, as well as the circumstance that the person who has accepted the problem is obliged to solve it. Apart from evoking anger, the situation of an insoluble task may compel the testee to transfer the search from the real to an imaginary situation. In imagination, the internal and external barriers become less rigid, i.e., more surmountable. A person actually remains inside the field but sees the way of attaining the goal as not so impassable. Evidently, it is equally important to study the refusal to tackle a problem and its acceptance and solution.

Thought activity aimed at solving a problem often unfolds in a situation of conflicting motives (the problem is challenging but one really ought to be writing a boring essay). The problem may be unpleasant, but refusal to solve it will

entail a punishment. When negative motivation prevails, refusals to solve the problem begin to crop up, and may assume a variety of forms. The simplest one is withdrawal from the situation of the problem (for instance, a psychological experiment); sometimes, solution may be postponed. From time to time, the refusal is disguised: another problem is taken up against which the person who has set the original task cannot possibly object. A negative attitude to the problem may manifest itself in deceit: the testee insists that it has already been solved, that his effort is unnecessary and that he has actually been released from the obligation to solve it, although this is not so. In case of negative motivation, there is additional significance to all sorts of bans that "block" the refusal to deal with the problem, including physical bans (a person is locked up until he has found a solution), social bans, and psychological influences ("I am sure you are clever enough").

§2. The Thinking Individual

Personality is often described as the sum total of the features characterising an individual. This broader definition of the personality actually blurs the borderline between the concepts of "personality" and "individual". In examining personality understood in this way, man's differential-psychological characteristics are revealed. This is done by means of questionnaires, observation of a person's behaviour, and analysis of his performance in dealing with specific types of tasks. Any language has a substantial number of words denoting individual traits that are directly connected with thinking (cunning, resourceful, quick-witted, inventive, shrewd, wise). Other traits may be obliquely associated with thinking (a quick- or slow-moving person will most probably demonstrate these characteristics in thinking). It would seem that this is the simplest and most effective method of research into the manifestation of the individual's traits through his thinking. In actual fact, however, the words describing these traits frequently have a number of meanings, may designate features of activity and the individual's basic traits, explaining why a person behaves in a certain way. Sometimes a trait is interpreted as an individual's particular dimension. Scales have been compiled which embrace all degrees to which some feature is expressed, from the lowest to the highest value, and the individual is rated according to the place he occupies on the scale. A trait is also used to indicate type.

Psychology distinguishes between the variants of individual traits. There is a certain comprehensive, all-embracing characteristic (which is sometimes referred to as Gestalt), that is "grasped" as a result of immediate perception of a person, and precedes basic reflection and psychological analysis. Children learn to correctly use the words denoting human traits not possessing any apparent psychological knowledge but basing themselves only on practical experience. The overall impression of a person may be either fleeting or the result of sufficiently lengthy observation. When an individual is examined systematically, a trait is inferred from responses or actions observed in specific situations. Questionnaires offered to people usually name the situations in which the trait under examination must transpire. In other cases, the degree to which some feature is manifest is evaluated by means of rating scales, on which the degree of the trait's prominence is matched by a concrete behavioral act. A trait manifests itself, to some degree, in certain actions or it determines them. Traits of this type are described not only for their presence or absence, but are evaluated quantitatively through the degree of probability of their manifestation. Psychological literature draws a line between in-depth and superficial traits. A current method of studying the individual is establishing statistical links and correlations between traits. A study of individual traits and qualities is also conducted.

Thought activity always has original characteristics conditioned by both the subject's personality and individuality. Individual characteristics are demonstrated in the ability to see a problem situation and formulate a problem, in the specifics of one's analysis and use of the problem's conditions. It is also revealed in the correlation between the conscious and the unconscious, in the nature of the emotional regulation of the search, and in the tactics of goal-formation. Psychology textbooks traditionally speak of "mental qualities", certain individual psychological characteristics that affect, *par excellence*, the progress of thought activity: its depth, scope, flexibility, independence, speed, and stages. Among the traits exhaustively analysed in psychological writings are those designated by the terms "suggestibility" and "critical faculty". Suggestion is a form of purposeful influence exerted by one person upon another which is not rationally substantiated. This being so an impression may arise that suggestion is directly opposed to thinking.

In analysing the phenomenon of suggestion and the person's individual-psychological trait described as suggestibility, they

have to be considered against the opposite phenomenon and trait, criticism and the critical faculty. In the context of psychology of thinking, the critical faculty is usually interpreted as a mental quality and defined as conscious control over the progress of man's intellectual activity. I would like to quote some of the leading Soviet psychologists. Boris Teplov defines the critical faculty as an ability to objectively evaluate one's own thinking, carefully consider all the pros and cons of the emerging hypotheses, and subject them to comprehensive verification. Sergei Rubinstein believes that verification, criticism and control characterise thinking as a conscious process. Anatoli Smirnov associates the independence of thinking with possession of the critical faculty, i.e., the ability not to succumb to the suggestive influence of other people's ideas, but to assess them carefully and critically, discern their weak and strong points and uncover both their valuable elements and errors. He also stresses that independence and critical thinking are sine qua non in a creative personality. Bluma Zeigarnik regards the critical faculty as an indication of the wholeness of the personal-motivational sphere and points out that it is the ability to act, compare, verify and set right one's actions in a well-thought-out manner and in accordance with expected results.

Suggestibility has traditionally been considered the opposite of the critical faculty. Among the formative factors that have been named are weakness of the subject's logical thinking, fairly low intellectual level, unconscious obedience to the demands set by the environment. Suggestibility is regarded as an undesirable trait impeding adequate intellectual work. The process of suggestion is interpreted as direct introduction into the psychic sphere of new ideas, sensations and actions in the absence of a critical attitude and understanding on the part of the subject, i.e., circumventing his critical personality. Lack of critical character, of logical reasoning, lack of awareness of the very process of perception, impossibility of voluntary correction of suggested information are viewed as the principal features of the state of suggestion. A drastically differing attitude towards suggestibility and critical attitude and their role in intellectual activity is demonstrated in some of the empirical research aimed at bolstering man's creative abilities (A. Osborn's "brain-storming" method, and Gordon's method of synectic training). To enhance the creative potential of individual subjects and groups these authors recommend measures to reduce critical attitudes and thereby raise suggestibility, to release the psychological mechanisms "in charge" of a creative activity.

The relationship between suggestibility and the critical faculty as the subject's individual-psychological features, on the one hand, and productivity of his thinking, on the other, depends, to a large extent, on what is being suggested (a concrete idea, ready-made knowledge, moral position, role, emotional state). It also depends on the aspect of the personality towards which the suggestive influence is directed (cognitive, motivational), that towards which the subject proves suggestible and towards which he displays a critical attitude (attitude to knowledge, to oneself, to other people). It is completely wrong to deny that man is capable of unconsciously analysing the suggested content. Specific forms of analysis and control are realised at the unconscious level: even in deep hypnosis, it is impossible to suggest anything that goes contrary to the personality's system of values. Suggestion becomes more cogent when it is sensibly combined with stated arguments and reflects a real state of affairs. Suggestibility and critical attitude are not stable characteristics. Depending on the situation, they may be more or less pronounced, determined as they are by the person's subjective state and the nature of the activity in which he is engaged. Even everyday observations show that when a person is urgently looking for a way out of a predicament, when he is excited and under stress, he becomes more credulous and is ready to follow any advice. Specialists have noticed that suggestibility is more readily detected in those fields in which the person is least informed. A drop in critical attitude may be achieved in two ways: first, by direct instruction ("to be creative, uninhibited, original, to suppress the tendency to criticise oneself and one's ideas, not to be afraid of others criticising you"); and, second, by providing favourable external conditions which decrease critical disposition indirectly (compassion, support, encouragement, approval of the partners, overcoming the fear of "looking stupid").

An absolutely negative attitude to criticism can hardly be justified: for a creative act to be accomplished, one must first critically evaluate the situation, to see the problem, to set the goal. Sensitivity to problems is regarded as an indicator of creative potential, and since it is a consequence of the functioning of the critical mechanism, this quality must play a positive role in the structure of creative activity. A great deal of research is needed to give an assessment of the impact produced by suggestibility and the critical faculty. One must describe and analyse the matter with regard to which

the subject displays suggestibility or criticism. The process of setting new original goals is favourably affected by the lowering of the subject's critical attitude towards himself and his personality traits, which enhances the suggestive effect of his own thought activity and promotes goal-formation. A stronger critical attitude towards the outside world and other people also proves desirable. The role of suggestibility and the critical faculty at the different stages of intellectual activity—in setting and accepting a goal and in attaining it—is subject to change. Criticism as a self-evaluating activity has a positive effect at the stage of reflective thinking but may become an impediment when imagination sets to work, when new ideas are advanced and new goals are formed. The subject's suggestibility may be a positive factor making it possible to actualise and develop creative talents precisely by changing the process of goal-formation, by an in-depth and consistent introduction into the psychic sphere of new goals involving creative activity.

Special analysis has shown that:

1) suggestibility and the critical faculty are major personality factors exerting an impact on thinking and goal-formation;

2) the critical faculty and suggestibility reflect the functioning of a single controlling mechanism;

3) the content that is subject to assimilation as a goal incorporates two structures, actual and connotative, which are simultaneously analysed by the subject in accepting a goal;

4) a shift of emphasis towards one of the structures during the analysis produces acts of either suggestible or critical behaviour;

5) one must never counterpose suggestibility and the critical faculty as an absolutely positive vs an absolutely negative quality of the psyche. Each contributes to the subject's activity and has a place in the process of goal-formation;

6) in experimentally varying the subject's suggestibility and critical attitudes, it is possible to direct the process of goal-formation.

Vivid descriptions of individual-typical features of thinking have been given by clinicians. Ernst Kretschmer, who believed that thinking and constitution are linked, noted that scientists belonging to the cyclothynic type display a capacity for extremely extensive work, an empirical bend, and fondness for popularisation. The schizothymic type demonstrates a tendency for theoretical research, predominant interest in form as opposed to interest in content, a love of orderly structures, of

the purely formal, leanings towards the suprasensual, the irrational.

Pyotr Gannushkin described intellectual activity typical of some forms of psychopathy. The constitutionally depressive representatives of the cycloid group show a dislike for work irrespective of its content, and tend to tire quickly. Moreover, they are inclined to see only mistakes in what has been done and only difficulties and snags in what has to be done, so that they become dispirited even before they have started. For them, intellectual work has an unpleasant colouring and is accompanied by great strain. The constitutionally excitable representatives of the psychopath group are outwardly brilliant, and have wide-ranging but unstable interests. Schizoids tend to build unrealistic formal structures based not on facts but schemata resting on the play of words and randomly combined concepts. Gannushkin especially stressed the schizoids' fondness for strange, essentially incompatible logical combinations, for bringing together concepts which in actual fact have nothing in common. Paranoiacs are inclined to form supervalent ideas: "The paranoiac's most important supervalent idea is usually that of the special significance of his own personality. Those who disagree with him, who think differently are, at best, merely stupid, and at worst, his personal enemies." His thinking is shaped to the formula: only that can be correct and right which I want and like. As a result, the paranoiac is incapable of forming sound ideas about his own personality in the context of relationships with other people. The group of hysteric psychopaths produces strikingly contradictory judgements in which logical correlations of facts and sober assessments are replaced by groundless phantasies. They are unable to hold their imagination in check. Organic psychopaths (with a degree of inborn mental underdevelopment), according to Gannushkin, have difficulty in applying knowledge to reality, have very little initiative and originality. These are banal, commonplace and vogue-following people.

Describing the thinking of people with an extraverted *attitude*, Carl Jung noted its orientation towards the objective (facts, ideas). The extraverted thinking type seeks to put all his vital manifestations in dependence on intellectual conclusions which in the long run are always oriented at the objectively present, either at objective facts or at commonly accepted ideas. Given the intraverted attitude, thinking is oriented, above all, at the subjective factor, facts are of secondary importance, with primary value given to the development and representation of a

subjective idea, the initial symbolic image which is present in the person's mind with a varying degree of clarity. The introverted thinking type tries to go deeper, not to expand, and his judgements refer to the object to a lesser extent than the subject.

However, even if descriptions of individual and typical characteristics of thinking representing the different biological constitutional types, are indeed extremely vivid and convincing, the very link between the characteristic features of thinking and the individual's biological and physiological characteristics, as well as the nature of this link, still remain obscure. They are subjected to special analysis in differential psychophysiology, which studies the formal dynamic characteristics of man's thinking.

§3. Thinking and Self-Awareness

A person is not only aware of the world and the people around him but of himself, his psychic processes, states and properties. Engels noted that "history is only differentiated from natural history as the evolutionary process of *self-conscious* organisms". Self-awareness is usually viewed from the image and the conceptual angles; psychologists speak about the ego image and ego concept, the image of oneself and the knowledge of oneself. In philosophical literature, they are united into an integral ego image. However, as we already know, one must distinguish between thinking and knowledge, and therefore, together with the commonly accepted term ego concept, we consider it necessary to introduce a less customary term ego thinking, meaning the process through which man attains knowledge about himself forming (or transforming) his ego concept, *the process of realisation,* in which man as a personality, an individual is not only the subject but also the object of thinking. It has been proved that psychic phenomena are formed before man becomes aware of them. Lev Vygotsky noted that the presence of a concept and the realisation of this concept do not coincide either in the time of their origin or in their functioning. Analysis of reality through concepts begins much earlier than the analysis of the concepts themselves. Ego image is a complex multi-faceted phenomenon which includes knowledge about oneself at a given time of one's life, the knowledge of what one would like to be, the knowledge of what one should be like, the knowledge of what one can become, the knowledge of how one

should project oneself, and the knowledge of how others see him. Ego image is also characterised by the number of personality traits of which a person is aware, the complexity and degree of generalisation of these traits, and their qualitative characteristics. An important aspect of ego image is the contradictory character of the knowledge making up the image.

To a greater or lesser degree, thinking is engaged in all tasks offered to the testee in studying their self-awareness. In case of free self-description (the answer to the question "What am I like?"), it affects the frequency and sequence of references to one trait or another. One of the methods of studying self-awareness involves *classifying* cards containing ready-made judgements, from those that describe the testees' personality and sensations in the most accurate way, to those which do this the least accurately (classifying is one of the methods used in the study of thinking). The "psychology of thinking" and the "psychology of self-awareness" usually deal with their respective subjects with little or no correlation. In the meantime, this is essential both for "humanising" the psychology of thinking and "psychologising" the theory of self-awareness, the prevailing method of which is recording the results of self-awareness, of the already formed ego images.

Based upon this approach, one can distinguish two fields: thinking as the process of generating any knowledge about oneself (for instance, a clear idea of one's physical capabilities, or one's appearance), and thinking as the process of generating knowledge about one's own thinking, the properties of one's mind. As we have seen, thinking is frequently described through the ability to solve certain problems. Among the latter are tasks bearing the strongest relation to the thinking personality itself and its existence. "To find new meaning to one's life", "to overcome loneliness", "to harmonise one's goals with one's capabilities", "to resolve the conflict with other people"—these are a few examples of the "requirements" incorporated in the structure of a problem. As concerns its "conditions", as a rule they must be clearly identified, which is not easy. Personalised problem situations are sometimes marked by the person's fairly clear awareness of the presence of difficulties in communication or his vital activity. People seek to overcome them, to adjust to them, but they find it difficult to formulate (i.e., become aware of) that concrete requirement which has to be fulfilled to overcome these difficulties.

The establishment of the personality as a coherent system of personalised meanings (Alexei N. Leontyev) implies thought activity aimed at holding this system together. Maintenance of inner harmony and stability of the ego is accomplished not only by means of defence mechanisms but also through man's thought activity. A sound evaluation of one's capabilities is necessary for checking one's aspirations against them, for making these aspirations realistic. A source of thought activity in shaping or modifying self-awareness are incongruities and controversies in the person's knowledge of oneself: a) the knowledge received from others; b) and the knowledge generated independently but applied with reference to different spheres of vital activity.

At a certain stage of man's development, when self-awareness evolves, thinking itself becomes an object of cognition: a person starts having thoughts about thoughts, thoughts about thinking. The structure of self-awareness incorporates understanding of oneself as a subject of thinking, differentiation between "one's own" and "outside" ideas, recognition of a yet unsolved problem as one's own, realisation of one's attitude to the problem ("I can't help thinking about it") and of the motives of one's thought activity. Unique material for the analysis of the reflexion on thinking itself is provided by autobiographical writings which contain both the authors' ideas about their thinking, and descriptions of those conditions and factors that, in their opinion, have made an impact on thinking.

Charles Darwin wrote in his autobiography: "I have as much difficulty as ever in expressing myself clearly and concisely." But he also noted: "It has the compensating advantage of forcing me to think long and intently about every sentence, and thus I have been often led to see errors in reasoning". He noted the changes in the style of his intellectual work: "Formerly I used to think about my sentences before writing them down; but for several years I have found that it saves time to scribble in a vile hand whole pages as quickly as I possibly can, contracting half the words; and then correct deliberately. Sentences thus scribbled down are often better ones than I could have written deliberately." Pondering on the changes that had occurred in his intellect, Darwin wrote regretfully that he was losing aesthetic tastes: "My mind seems to have become a kind of machine for grinding general laws out of large collections of facts, but why this should have caused the atrophy of that part of the brain alone on which the higher tastes depend, I cannot conceive. ... I have

no great quickness of apprehension or wit. ... My power to follow a long and purely abstract train of thought is very limited; I have a fair share of invention and of common sense or judgement." Charles Darwin associated his success as a man of science with such traits as "the love of science—unbounded patience in long reflecting over any subject—industry in observing and collecting facts—and a fair share of invention as well as common sense".

An analysis of Darwin's autobiography makes it possible to identify some of the typical methods employed in self-awareness. First, this is the method of making comparisons between one's personality as it was at the various stages of one's life. Application of this method is based not only on retention in memory of results of earlier self-analysis but also the use of the various types of objectified "products", notes, etc. Darwin tried to evaluate the changes in his intellectual make-up over thirty years: "I think I have become a little more skilful in guessing right explanations and in devising experimental tests... this may probably be the result of mere practice, and of a larger store of knowledge." He noted changes in the motivation of his thought activity: "Music generally sets me thinking too energetically on what I have been at work on, instead of giving me pleasure." He also pondered on what was going to happen to his brain in the future: "I hope that I may die before my mind fails to a sensible extent." He thought back to the way his mind used to function, pointing to unutilised potential: "If I had to live my life again I would have made a rule to read some poetry and listen to some music." Pondering on the mental qualities and conditions that had determined his success, Darwin wrote: "It may be worthwhile for me to try to analyse the mental qualities and the conditions on which my success has depended; though I am aware that no man can do this correctly." A double-tiered verbal account takes place, first, to give oneself an account of one's own mental qualities and, second, to give oneself an account of the accuracy and completeness of this account. The second method of self-cognition, assessing one's capabilities against those of other people, is also represented in Darwin's autobiography: "I think I am superior to the common run of men in noticing things which easily escape attention, and in observing them carefully... I have a fair share ... of common sense and judgement, such as every fairly successful lawyer or doctor must have, but not, I believe, in any higher degree."

Darwin also operated with ideas of what thinking ought to be and formulated the goals he set with respect to his

own thinking: "I have steadily endeavoured to keep my mind free, so as to give up any hypothesis, however much beloved (and I cannot resist forming one on every subject), as soon as facts are shown to be opposed to it." He stated a definite attitude to the various methods of research: "This has naturally led me to distrust greatly deductive reasoning in the mixed sciences." Finally, he gave an opinion on the impact his work exerted on other people's ideas: "I should have influenced to a considerable extent the beliefs of scientific men on some important points."

However, an author's ideas concerning his own thinking are always influenced by his various concepts. Whereas Darwin stressed such qualities as "the love of science", "the ambition to be esteemed by my fellow naturalists", and "the higher aesthetic tastes", the distinguished contemporary scientist Herbert A. Simon believes that in the computer age, the greatest significance of the computer lies in its impact on Man's view of himself and his place in the Universe. In other words, the computer makes it possible to answer questions which Darwin, and many others, tried to resolve. Simon holds that of major importance is the question posed by Darwinism and by the revolution accomplished by Copernicus in the natural sciences several centuries ago: is man's dignity, the sense of belonging and self-respect conditional on his place in the Universe as something special and unique? After Copernicus and Galileo, man ceased to be the species occupying the centre of the Universe. After Darwin, he ceased to be the species created by the Lord and endowed with a soul and reason. After Freud, he ceased to be the species whose behaviour is potentially regulated by a rational mind. After thinking and teachable mechanisms have begun to be created, man, in Simon's view, has ceased to be the only species able to handle the environment in a rational, sensible and complex manner. "Perhaps the greatest significance of the computer lies in its impact on Man's view of himself. No longer accepting the geocentric view of the universe, he now begins to learn that mind, too, is a phenomenon of nature, explainable in terms of simple mechanisms. Thus the computer aids him to obey, for the first time, the ancient injunction, 'Know thyself'."

An extremely interesting field of study are the views of top-ranking chess-players about their own play. The point is that chess is a model for elaborating the principles of computer programming, and this field has produced brilliant theorists. Among them is Mikhail Botvinnik, ex-world champion, Dr.Sc. (Tech.), who has recently been devoting himself to perfecting chess pro-

grammes. This work is based on the assumption that man's thinking can be adequately described in terms of "algorithm", "programme" and "information processing". Speaking at the International Conference on Artificial Intelligence held in Leningrad in 1980, Mikhail Botvinnik formulated a number of important points. He said, among other things, that man's programmes are so superior to those of a computer that despite a much lower speed of operations and lesser memory volume, man reaches far more profound decisions in coping with a problem. One must assume, he noted, that man uses a clearly defined programme for decision-making in the problems necessitating selecting the correct solution out of a certain range (only in this case can it be comprehended and formalised), that the programme can be fed to a computer, and that a chess-player searches for a move by algorithm.

Psychologists see intellectual activities in a different perspective. They stress the significance of self-appraisal and direct sensual images for the functioning, refer to creative attitudes and a critical attitude towards oneself. Getting to know oneself is associated with self-regulation, modifying one's self-appraisal, which can be executed in a variety of ways: "discrediting" (the method used to change unfavourable comparisons between oneself and the opponent), "idealisation" (correcting a distinctly favourable comparison of oneself with the opponent), "reappraisal" (changing one's attitude to the actions which are evaluated as either very unfavourable or very favourable for the subject), "stimulation" (planning and executing actions designed to produce serious difficulties in the person's own activity). They also use such concepts as "goal-formation", the emotional states of "certainty" and "uncertainty", "willpower", "caution", "readiness to take risks", "psychological initiative", "level of aspirations", "the activity of the subject's own position", and "interest". They note that in problem situations where any single best solution cannot be found, the opponent's character traits assume tremendous importance together with the appraisal of the objective situation. An increase in the complexity of thought activity against conflict background gives rise to the emergence of its second dimension, "camouflage". Genuinely indicative characteristics of the creative process can be comprehended only through objective scientific study.

Henri Poincaré believed it important to look at "what passes in the very soul of the mathematician" and that "the best thing to be done is to appeal to personal memories". His own memoirs contain the following episode: "We were boarding an omnibus

on our way somewhere; at the moment when I climbed the step, an idea came to me, without, it seemed, any preparatory thinking having been done by me." Poincaré's analysis contains not only descriptions but also interpretations, for instance, the statement that unconscious work "is not possible, or at least not productive, if it is not preceded and followed by a period of conscious work". He spoke about the sensation of complete certainty striking one at the moment of revelation, and the possibility of its being misleading. He placed a great deal of importance upon the aesthetic sense performing the part of a "sieve" sorting out unconscious ideas. He spoke about doing work "despite himself", and stressed the importance of both the unconscious and conscious. But he also wrote that his views on the nature of creative work certainly needed verification, since they still remained *hypothetical.* This statement clearly conveys the heuristic value and limitations of self-analysis: its results are a source of hypotheses but not proof of the soundness of these hypotheses. Proof is yielded only by the results of an objective study of the psyche. An interesting aspect of Poincaré's analysis is that he used the image (i.e., the level of image thinking) in expounding his understanding of the essence of creative work in mathematics, e.g., "Epicurus's hook-like atoms". In his work *Science et Méthode*, he twice apologised for "the grossness of his comparison" but, he continued, "I do not know how else to explain my thought."

In psychology, the term "personality" is often used to designate different things, but each undoubtedly includes the personality's thinking. There is an opinion that a subject merits being referred to as a personality only when he has attained the development level at which he is able to regulate his own need-motivational states. Thinking is incorporated into this process as mediated cognition of one's own states and as a procedure of evolving the goals and means of such regulation. The vital function of self-awareness is self-regulation of the personality's behaviour. This is also completely true of thinking. This level of self-regulation is called reflexive. Reflexive thought processes emerge already at the stage of posing the intellectual task, which arises as a result of *comprehension* and analysis of the problem situation shaped by the discord between the subject's needs and capabilities. The most general phenomenon in which the reflective nature of thought activity manifests itself is the person's work, performed in the process of the search, to actively build those means which can help regulate mental actions, i.e., hypotheses, anticipatory schemata and models. There is a hierarchy of reflective regulation: a) reflecting and controlling individual

executive actions performed under a ready-made standard programme; b) man reflects himself also as a controller planning and evaluating his actions. The basis of efficient solutions of intellectual problems is always formed by the ability to *be aware* of one's actions. By "efficient" we mean such solutions which are not only free from error and are optimal but in which the subject can find and correct a mistake, and not display helplessness in the face of difficulties, and always completes the problem-solving. An efficient solution necessitates an awareness of the operations that control the progress of problem-solving and its result.

Expansion of man's self-awareness is part of socio-psychological training and is designed to help man cope with problems facing him. Enhancement of group members' self-awareness is associated with receiving information concerning the way people perceive each other's behaviour. Comparing one's image as one sees it with the way it appears to others, from first impressions and in evolution, usually leads to the *discovery* of the distance existing between the two, often a totally unexpected one. This may reduce the number of cases of unjustified *generalisations* in interpersonal perception and interpersonal relations. These discoveries and generalisations convey the role played by thinking in the changes that occur in self-awareness. In a group, a person becomes aware of his potential for cognising other people and discovers what sort of impact he exerts on the others (both unwittingly and intentionally). Thinking manifests itself through one's forecasts of other people's appraisal of oneself, analysis of other people's appraisal of oneself, analysis of other people's opinions of oneself (differentiating between what actually exists and what is self-ascribed). The formation of an adequate ego image is closely connected with the reflexion of the establishment of the group's psychological structures. Here is a description of one instance of such reflexion. Each group member in turn closes his eyes, while the rest take places at a distance from him which symbolises the psychological distance between them and the person in question. Each makes a mental note of his place, and the alignment is then broken up. The person is then allowed to open his eyes, after which he puts each group member in a place which, in his opinion, this other person could take with reference to him. And, finally, each group member re-assumes the place in which he had originally put himself. The whole procedure is intended to give each person an opportunity to verify the adequacy and accuracy of his idea of the group's sociometric structure, specifically, his own place in it.

Chapter Nine

THE PRINCIPLE OF DEVELOPMENT IN PSYCHOLOGY OF THINKING

§ 1. The Biological Early History of Man's Thinking

The principle of development is a major one in scientific psychology. The evolution of psyche may be considered phylogenetically, historically, ontogenetically and functionally. The preceding chapters dealt mostly with the functional aspect, which is the leading one in approaching the subject from the general psychological position. Let us now review the other aspects of the study of thinking, starting with the phylogenetic. This task necessarily compels us to raise some of the more general questions of mental development.

Human psyche is a comparatively late product of evolution. Therefore, the more general features of the psychic are to be sought outside man's existence. But where exactly? The earliest concept is that of the generally animate nature of matter, which, however, has been refuted by science. An opinion has been advanced that psyche is a property of everything living (the noted animal psychologist Vladimir Wagner maintained that the criterion of the psychic is irritability, which is a property of all living beings). Another opinion held that the psyche is a property of only those organisms which have a nervous system. At present, the most thoroughly developed hypothesis concerning the origin of psyche (and, consequently, the primary forms of reflection) is that of Alexei N. Leontyev and Alexei Zaporozhets. According to it, the elementary form of psychic reflection is sensibility, the ability to respond to stimuli which, taken by themselves, have no part in metabolic processes but act as signals and orientators (abiotic stimuli). This is what distinguishes sensibility from irritability, which is characterised by responses to the biologically significant stimuli.

In order to exist, any living organism must carry on an exchange with its natural environment. Metabolism is one of the fundamental characteristics of life. Each living organism sets

certain requirements with respect to its environment. If these requirements (for instance, an influx of certain substances) are met, the organism survives; if not, it dies. The relation of the organism to the environment is active and selective right from the start; all influences are "classified" as either good or harmful, and responses to them differ. At the same time, the animal organism is much more active in its relation to the environment than plants. This is expressed in the *search* for conditions and objects necessary for its existence. The search is executed, above all, through movement, locomotor *behaviour*. The alternative to the search is *avoidance* of harmful influences. The organism's requirements turn into *needs*. A need is a state of necessity as regards external objects essential for existence. That which is necessary is not always to be found in the immediate environment, and a chain of actions may be required in order to get or find the object which can fulfil the need, i.e., independent behaviour is indicated. In turn, behaviour is possible only when the organism is able to *orientate itself* in the environment, i.e., responds not only to the influences which are directly involved in its metabolism but also to the stimuli which precede them, warn of the possibility of their emergence. There is expansion and qualitative modifications of the area with respect to which the organism is responsive. Such stimuli may be signals only in case they are linked up with the influences directly involved in metabolism, the signals are linked up with the organism's basic biological needs through them. The concept of "having the quality of a signal" in the biological and the psychological sense necessarily implies a certain state of the need with respect to which the signalling influence becomes meaningful, i.e., warns that conditions for the satisfaction or non-satisfaction of the need may arise. Sensibility is a form of reflection by the organism of certain properties of the environment through the organism's states. The emergence in some organisms of the ability to orientate themselves with respect to biologically neutral influences is the initial form of psychic life. It emerges, not accidentally but naturally, as a product of the growing complexity in the relationship between the organism and the environment, as an apparatus serving the interaction and actively involved in it. Psyche is vitally important and performs an active part in behaviour. In order to orientate itself, the organism must take into account the specific features of the object with regard to which the orientation is taking place. It must *reflect* them. The reflectory function of the psyche is represented in its most elementary, primary form, i.e., sensibility, the ability to have sensations.

Orientating in the form of sensibility reaches a high level of development in animals. One of its evolutionary trends is the transition from general non-differentiated (non-specific) sensibility to the differentiated and specific type. Differentiation proceeds in the direction of more subtle and selective responsiveness to outside influences which, as it were, represent the different classes of energy, the different types of influences: acoustic, mechanical, thermal, chemical, optical. Speaking about orientating among animals, which is represented as sensibility at large, one can define the following ideas. Animal orientating develops in the direction of stronger differentiation, greater subtlety, more accurate perception of those influences with respect to which the orientating process has to be developed. Determinative in this development is the biological significance of those influences that fulfil the function of orientating points. It is significance for vital activity that determines the degree of intensity in the development of sensibility with respect to the various orientating points. The differences in the way of life give rise to differences in the development of orientation typical of different species (the sense of smell, eyesight, etc.). The concept of the "leading sensibility" registers a certain hierarchy of the different types of sensibility characteristic of a given species. Animals reflect the world in a way that is different from that of man, in a variety of ways, depending on the vital activity and the structure of the organism's behaviour. Psychic reflection is always active and selective, and serves adaptive behaviour—these are its most general properties.

Since psychic reflection emerges and develops within the behavioural structure performing an orientating function, one must have an idea of the basic features of behaviour itself. In the most general way, it is described as a process of the organism's active interaction with the environment. The final result of this interaction is the organism's adaptation to the environment, the requirements it sets, and gratification of its needs. Movement, as has been noted, is a major manifestation of the organism's active interaction with the environment. There are two main forms of behaviour, innate and individually variable.

Wide currency has been given to the term "instinct" used to designate one of the forms of behaviour. It has a number of meanings, which necessitates outlining its major usages. The first usage (historically) is associated with animal behaviour in general (with no reference to the individual species), as distinct from human behaviour. The following definition has been

advanced: "Man's behaviour is rational, while animals follow their instincts." Instinct is regarded as the alternative to rationality; instinctive behaviour is irrational, blind, i.e., independent of the external conditions. Instinctive behaviour is *ready-made*, one need not learn it, it is *innate*. In the context of the problem we are now considering, the phylogenesis of thinking, this means that thinking is typical only of man and, in fact, has no biological early history. As knowledge about animal behaviour accumulated, the term "instinct" began to be used in a narrower sense to designate *one of the forms* of animal behaviour. The need to narrow the term down arose because the growing body of observations of animal behaviour indicated that this type of behaviour is not all that blind, that it adapts to the demands of the environment and that it cannot be understood other than as adaptation to these demands. The second usage of the term instinct is innate behaviour of animals.

Yet another, third usage of the term exists, which continues to crop up in contemporary writings and has a direct bearing on the study of the human psyche. It is sometimes used to describe not behaviour proper, but the motive forces behind it, an impulse towards behaviour or movement. This tradition persists to this day. When scientists speak of man's instinct, they realise that it is difficult to discover ready-made behaviour in a newborn infant. When references are made to the "feeding instinct", the "defence instinct", or the "sexual instinct", the term is used in the meaning that is close to "biological or organic need".

Let us dwell more on the second usage of the term, the one designating a form of animal behaviour. Identifying instinct as a form of behaviour was a step forward, signifying as it did rejection of global ideas concerning animal behaviour in general. However, instinct as a form of behaviour was counterposed to another form, individually variable behaviour, which is not inherent in the newborn organism but evolves in the course of its individual existence. The opinion now was: individually variable behaviour of animals is intelligent in the sense that it is shaped with due account for external conditions which change in the course of a given organism's life and the various stages of its behaviour; it is adaptive with regard to the changing conditions.

Intelligence in the broad sense was now associated with the organism's dynamic or immediate adaptation to the requirements of the environment, not those global requirements that secure survival and reproduction of a species but those that emerge now in coping with a given concrete task. As concerns innate behaviour, it was still interpreted as "rigidly programmed" and, in this

sense, not variable, not adaptive to the environment. Instinctive behaviour was viewed as a form of adaptation fixed in the history of a species development (if you will, solution of certain classes of problems by a given species). In the 19th century, Jean Henri Fabre, a scientist who has done a great deal to describe and analyse instinctive behaviour, particularly insisted on the idea of its rigidity and unchangeability. Here is an example that has become classic: some species of wasps use grasshoppers as an incubator for their progeny: the wasp paralyses the grasshopper stabbing it three times at the spots on its back. Located under the spots are the pertinent nerve ganglia. The victim is then used for the laying of eggs, and the larvae are ensured food. What is required are three stabs at three predetermined spots. A convincing example of very rigid behaviour indeed.

It would seem that the theory of rigid, unchangeable behaviour has been convincingly proved. However, even the example cited above has been reassessed. Additional observations have put in question the original theoretical premises. Indeed, the grasshopper is a victim of the wasp, it is paralysed by three fixed stabs. But, if we look closely at the first phase, the encounter of the wasp and the grasshopper, it is easy to discover that the grasshopper is not passively awaiting the moment when the three programmed stabs are made. It *resists*, it fights the wasp, and in the course of the struggle the organisms that have clashed may find themselves occupying a wide range of spatial positions with respect to one another. The number of these positions is so great that they cannot be calculated in advance. Consequently, the proverbial wasp is forced to adapt to the current moment, the spatial position occupied by the grasshopper at each given moment. Adaptation is essential for getting at the "three spots", whose position in space changes constantly.

An idea has emerged that the element of variability, adaptability, changeability is present in any behavioural act, even those that have been interpreted as specimens of rigid, non-adaptive behaviour. In this sense, *any behavioural act is rational and may be viewed as a very distant, but still a prototype of the future complex mental, intellectual activity of man.* At present, most psychologists do not in fact support the idea of the need to strictly separate innate (instinctive) and individually variable behaviour. Adaptation is viewed as a changeable component, the actual behaviour of any living organism is regarded as a fusion of fixated components and individually variable components in an integral behavioural act. However, there is still the question of the share of each of these components, representation of in-

tellect (in the broad sense) in integral behaviour. It is determined by the characteristics of the organisms' way of life (with reference to the species). In the structure of an individual's behaviour, a prominent part is played by the actual state of the need: the higher the excitability of the nerve centres corresponding to some biological needs or others, the higher the share of innate, ready-made components of behaviour, and the lower the degree of its "intellectuality". Conversely, given a comparatively low excitability level, individually variable components may prevail. At the same time, most researchers emphasise the difficulty of drawing a distinct line between the innate and the individually variable in behaviour (even at the foetal stage, the organism already feels the impact of the environment). Facts have been recently piling up which indicate that what is innate is not behaviour but certain prerequisites, readiness for a certain type of behaviour (a vivid example is the reaction of following).

Behaviour may be analysed without reference to the correlation between the innate and the individually variable, from the viewpoint of its overall structure. Such analysis makes it possible to gain a better understanding of the unique features of man's conscious activity as compared to the most complex forms of animal behaviour. Behaviour is aimed at gratifying some need (e.g., feeding, defense, sexual). Complex behaviour incorporates individual behavioural acts which are distinguished on the basis of attainment of biologically important results which, however, act as intermediate stages on the path towards completely satisfying the needs which underlie a given type of behaviour. Feeding behaviour may be broken up into such acts as search for food and catching the victim (especially when it resists). Complex behaviour always has two phases. The orientating processes form differently, depending on the phase: not infrequently, a substitution of the leading sensibility occurs.

The search for objects may, in turn, have different forms, depending on how specialised the search is and the degree to which it is restricted by the range of objects at which it is directed. At the phase of capturing the victim, relatively independent behavioural acts may be singled out: waiting, lurking, stalking, and pursuit. Behaviour is organised hierarchically, with the basis formed by the hierarchy of biological needs. It undergoes a change within an organism's lifetime, which leads to a re-distribulion of the stimuli's signalling rank. The search for the object of the need often has to begin even before its actual discovery. The first phase of the search is initiated by the signals sent by body organs and associated with interoception. The

organism's activeness, which does not passively wait for the appearance of an object capable of satisfying its needs, manifests itself in its search for objects that may become objects of needs. This is how the relative autonomy of behaviour with regard to the environment is expressed.

Let us consider in more detail that form of behaviour in which individually variable components dominate. As a rule, it is referred to as learning, whose study forms a large chapter in experimental psychology. One of the methods, which has already become classic, is developing the skill of passing through a labirynth, i.e., artificial environment. This behaviour is described for the time expenditure and the number of times the testee gets into a dead end. A feature of experiments involving labyrinths, as well as many other situations of learning, is the fact that *one and the same problem is posed before the animal's behaviour more than once.* The phenomenon has been described as gradualness of learning a skill (fewer mistakes and less time required) and its varying stability. Of special interests are experiments involving learning in a situation that occurs only once. For instance, a laboratory has two feeders. A piece of meat is put into one, with the dog experimented on observing it (the animal is held so that is could not make a dash for it). The meat is then unobtrusively substituted for bread crumbs. Released, the dog rushes up to the feeder, finds the crumbs, refuses to eat them, and continues its search behaviour. A dog which has *not* been shown the meat placidly consumes the bread crumbs. The phenomenon of rejecting an object which, in principle, can satisfy the need for food, indicates that prior to the search (as a result of the experimenter's demonstration), a certain psychic reflection of the object of the need has been formed. It has been given different names: "image", "schema", "expectation", "cognitive map", "attitude", "acceptor of action", and is formed during a single demonstration. The temporal parameter is an important characteristic of the orientating process making it possible to judge whether the organism orientates in a situation gradually or promptly (practically within a moment) before adapting its behaviour to it. The phenomenon of quick orientating, originally described with reference to higher animals, has proved common enough in the animal world; it is encountered among birds, and even, in some of its elements, insects.

A mental reflection which is developed by an animal and which takes part in regulating adaptive behaviour is not homogeneous. We shall describe a number of parameters on the basis of which it is subdivided into types: modality of the stimulus

(chemical, mechanical, thermal); the degree of complexity of the stimulus with respect to which the organism orientates itself (reflection of individual properties, reflection of entire objects, reflection of complex relations among outside stimuli). Intelligent animal behaviour is a form of individually variable behaviour, which is most prominently expressed among higher animals but is also present, in a rudimentary form, not only among the anthropoids. Experimental research into the solution of problems by animals which has ousted the initial anthropomorphous views about "the animals' ability to reason", has produced differentiation between the two views, behaviour based on the trial and error method, and behaviour based on comprehension, i.e., perception of relationships. "Comprehension" was the name given to reckoning with the properties of a situation, whereas behaviour based on such consideration was called intelligent. Rational behaviour was counterposed to random behaviour. Later, two extreme viewpoints merged. Wolfgang Köhler used the following parameter as the criterion of rational behaviour: the emergence of the overall solution in accordance with the structure of the field. Robert S. Woodworth wrote: "... this perception is never complete at the outset, in any situation that can be called problematical. The situation needs to be explored and seldom can be satisfactorily explored without locomotion or manipulation. But even the first view of a situation reveals the outline of the problem sufficiently to limit to some degree the range of exploration and manipulation."

The phrase "intelligent behaviour of animals" has two meanings: "intelligent" in the sense of adaptive, the sense in which any individually variable behaviour is intelligent. Even instinctive behaviour contains elements of intellectuality. In the narrower sense, intelligent behaviour means a sub-form of individually variable behaviour. Classic research in this field has been carried out by Ivan Pavlov, Natalia Ladygina-Kots and Wolfgang Köhler. For Köhler, intelligence of behaviour in the narrower sense consists in using roundabout ways (to go away from the bait so as to approach it later), "using tools", and "manufacturing tools". As noted, intelligent behaviour is connected with reflecting the relationships in a situation and with quickness of orientating. The latter's biological meaning is clear: some behavioural tasks cannot be coped with by trial and error (this method is clearly unsuitable in running away from a predator: an error may cost one's life). Among the prerequisites of intelligent behaviour is precedence of orientating with respect to immediate locomotor tests, and lengthy retention in memory

of traces of outside influences. Intelligence in animal behaviour makes itself felt in anticipation and extrapolation. A dog running across the road should anticipate the position of a moving car at the moment when their trajectories cross. The most complex manifestations of intelligent behaviour are probably attempts to manufacture tools: when one stick is attached to another, a new property of the new stick is singled out, that of being a tool, as well as a new property of the original sticks, the ability to be attached to one another. A sphere of the mental reflection of the outside world begins to develop. This is associated not only with making use of the orientation points present in the environment, but also with actively identifying them by acts that begin to stand out from behaviour. Kurd Fabri believes that the earlier identified criteria of intellectuality are no longer applicable to anthropoids alone but "spread" over the behaviour of other higher vertebrates. He sees the qualitative distinction of the anthropoids' behaviour in the development of the primates' manipulatory activeness, which allows them not only to visually perceive the connections between objects but also to get to know the structure (including internal structure) of the objects of manipulation. Vision in primates is also "fosterable" through the muscle sense. Primates, as Kurd Fabri believes, are able to perceive and take into account the cause-and-effect links and relationships, but only as visually and sensually perceivable physical (mechanical) links.

An interesting trend in the development of orientating is connected with group behaviour and interaction between individual members of the species. What is taking place is mutual orientation of organisms, including that with reference to their movements and postures, and communication unfolds, indicating the results of orientating in the object-related world. For instance, the number of loops in a bee's dance depends on the distance, character of the food that has been discovered, the distance to it, and its location. In the animal world, the means of communication between members of a species reach a high degree of development. Drawing a comparison between them and the human forms of sound communication, a cshout can be used as a rough analogue. It is an expressive act objectively conveying information concerning the organism's state and through this, about some of the features of the situation that has produced this state. It is for this reason that it allows the other of the species to orientate themselves not only with reference to the organism's state but to some of the features of the situation. Orientating with regard to the expressive movements of other individual members

of the species (posture, direction of glances) serves the hierarchical relations in a group of animals (for instance, one must never look a gorilla straight in the eye).

§ 2. Historical Development of Man's Thinking

The emergence of human thinking can be understood only in the context of the establishment of human activity, whose basic form is labour, of man's psyche and of the appearance of language. The development of an individual's thinking is, above all, part of historical development of thinking and cognition of all mankind. In order to understand the novelty that emerges at the human level, it is necessary to constantly correlate the psyche of man and that of animal, man's activity and animal behaviour. As is usual, the history of science and culture has been the scene of sharply differing views. According to one, the *difference* between man and beast is absolute, they are separated by an abyss. The extreme expression of this position is the concept that man is the crown of creation endowed with divine reason and will. Another viewpoint makes an absolute of the *similarity* between man and animal. It is most often advocated by natural scientists, who reason in this manner: if the behaviour and orientating activity of animals are so complex, incorporating as they do a large number of internal regulatory mechanisms, why conjecture about the existence of some additional processes that would only serve to complicate the already complicated picture? That is why it is so important to understand the dialectics of the difference and the similarity, those qualitatively new features that are formed in the course of the development of the human psyche and behaviour.

A major characteristic of man's activity is that it is essentially productive and aimed at transforming the environment. By productive we mean the ultimate formation of some product: this feature is brought into relief in analysing even the simplest forms of man's labour, which originates as physical labour. The transforming nature of activity means that through it, man modifies and transforms objects and the environment under the impact of his needs. Animal behaviour is directed, above all, at *adapting* to the environment. This constitutes its biological essence and the purpose of its development. As distinct from the adaptive nature of animal behaviour, man's activity is directed at its transformation—it is essentially constructive. Fashioning a tool out of stone is an example of this feature of human activity. This is not to say that in the case of man, adaptation vanishes altogether (man

still has to adapt, say, to a change of climate or to weightlessness), but it plays a secondary role.

Human activity has a chance to become transforming and constructive because in the course of it, even before he has created some product, man sets himself a conscious goal. Setting the goal is, as we already know, one of the functions of thinking. Within the structure of activity, independent component parts, actions, are distinguished. Thus, in the structure of physical labour thinking emerges as a means of preparing subsequent purposeful actions.

In differentiating between man's activity and animal behaviour, one must not restrict oneself to merely pointing out the part performed by action. One should take into account the distinctions between the needs of a living organism and basic human needs, the satisfaction of which is pursued by behaviour and activity. Human needs are satisfied by means of the objects that act as the fruits of production, i.e., of some social activity of other people. They also reflect thought activity. Man's needs that have counterparts in the animal world (the so-called bodily needs) undergo a qualitative transformation. New needs and new hierarchical relations between them emerge. Needs not only direct and regulate human activity but are an object of cognition. "A rational need" is a cognised, evaluated need that gives rise to a definite attitude. Social, group and individual assessments of a need as "rational" may not always coincide, and this is only natural. A need ceases to directly determine all subsequent behaviour, which is mediated by goals. Social experience becomes incorporated into man's activity. The simplest form of communicating it are labour implements and it is not by chance that they are called "humanity's first abstraction". In an effort to transform nature, and later for research purposes, man reveals properties that are concealed from immediate sensual perception. This activity is mediated by social experience represented by tools. A still more powerful means of accumulating social experience is language, which makes possible the emergence of consciousness, self-awareness and higher forms of self-regulation. A verbal definition of the requirements and a description of the conditions form a problem, and thinking is aimed at solving it. The unconscious form of psychic reflection also differs qualitatively from an animal's psyche: unconscious verbal generalisations are shaped in joint activity, in the structure of verbal communication, i.e., in conformity with the laws of the shaping of human psyche, yet they do not become conscious. Motor skills may be assimilated in the course of daily practical

activity, their composition remaining unconscious (imitation).

In the historical context, man's activity emerges as collective, joint activity, with individual activity later forming as an independent type. The correlation between the individual and the social (supraindividual) is one of the central problems of psychology of thinking. The group character of labour activity means that the participants must interact in order to attain a common result, coordinate their efforts in a concrete situation. What happens is division of the functions within a community, which includes not only simultaneous performance of separate acts by individuals but, also, the division of consecutively accomplished functions: preparing and executing an action. For example, one person makes a tool, and another uses it in action. The logic of the division of functions among people engaged in joint labour presupposes the need for performing such intermediate acts which, taken by themselves, are not biologically meaningful. These acts are called actions, processes of attaining a realised goal. Apart from actions directed at the object environment, specific actions are identified which are associated with communication among individuals in the course of joint labour activity. In his time, the distinguished animal psychologist Vladimir Wagner wrote: "Animal communication has one track while human communication has two". This means that, transmitting a message to another person through speech, we not only orientate him in an objective situation but do it deliberately.

Under Lev Vygotsky's theory, higher mental functions, among which is verbal-logical thinking, arise in the course of communication and joint activity as the functions "divided among people". These only later become individual ones. While labour processes are mediated by tools, higher mental processes are mediated by signs ("psychological tools"), among which language plays a major role. The emergence of new goals, i.e., actions in the course of joint practical activity, may hypothetically be visualised in this way. Coordination of joint efforts must include evaluation, a verbalisation of certain objective results achieved by other participants. The logic of joint labour processes demands that one person name some of the results of another person's actions *before* these actions have actually been performed. Verbal designation of the results of another person's actions is what a realised goal is about; goal-formation originates as a demand set to another person and accepted by him. Later, the same demand may be addressed to another member of the group and, finally, to oneself. A goal emerges as an entity within the structure of individual activity. Viewed historically, goal-formation is

shaped in conformity with the pattern of the formation of higher mental functions. The historical evolution of activity itself followed a number of routes. First and foremost, this is the development and the growing complexity of the tools themselves. Machines have been built which mediate the activity of large groups of people and have brought to life a specific type of activity required to operate them. Further on, there is the trend towards greater differentiation between creative and executive functions inside sensory practical activity itself (a craftsman and an apprentice), whose rudiments are already to be found in the primary forms of labour.

For psychology of thinking, the crucial event is that stage of the social division of labour when intellectual labour was separated from physical labour. For the first time, thinking assumed the form of independent activity possessing its own motives, goals and operations. Further evolution of intellectual labour is associated with the differentiation of its functions (typical intellectual tasks), differentiation between the types of intellectual labour. Intellectual activity itself becomes mediated by tools (calculators, computers). New relations become established between physical and intellectual labour, and new forms of joint intellectual activity arise. Individual activity, including its intellectual variety, which has branched off from joint activity, always remains socially conditioned (and in this sense "joint"). This is manifested through the use of knowledge generated by other people (both object-related and procedural knowledge, the latter pertaining to the methods of problem-solving). It is also demonstrated through the acceptance of already formulated (but not yet solved) tasks, the objective need to formulate, and then solve, a certain class of problems. At each stage of its evolution society, as it were, sets the boundaries for the development of individual thought activity (it is impossible to engage in intellectual labour before the emergence of social division of labour into intellectual and physical, it is impossible to become a cosmonaut before space exploration has begun). At the same time, individual activity leads to constant change and expansion of these boundaries. This happens because historically and socially conditioned thinking generates new knowledge, including some that is new to society.

A study of the historical development of cognitive processes, specifically thinking, is an independent part of the psychological science. The principal method employed here is comparative analysis of the thought activity of people living in societies standing at various stages of social and historical development. We

shall use the research conducted by Alexander Luria as an example. The material on which it was based was collected in 1931-32, when the Soviet Union was accomplishing a radical transformation of life along socialist lines, specifically, eliminating illiteracy. Observations were made on the outskirts of Uzbekistan, a Soviet Central Asian republic, at mountain villages and highland pastures. They revealed that "the structure of cognitive activity at individual stages of historical evolution does not remain unchanged, and that the major forms of cognitive processes—perception and generalisation, inference and discourse, imagination and analysis of inner life—are historically determined and change as the conditions of social life are transformed and more knowledge acquired." Illiterate testees demonstrated prevalence of visual-active and visual-image thinking. A fairly rapid transfer to verbal-logical thinking occurred as they were learning to read and write. One of the experiments used the already mentioned method of the "fourth being the odd one out", and involved a hammer, a saw, a log and an axe. It turned out that the testees found it extremely difficult to discard a log; they said that "they needed everything". The experimenter's story about a man who chose three objects excluding the log produced a comment: "Well, he probably had plenty of firewood!" Thus, the objects were classified not by verbal-logical operations but on the basis of visual ideas concerning the participation of objects in a practical situation. Mastered reading and writing produced a restructuring of thinking, and a categorial classification of objects. Similar results were yielded by experiments that involved finding the points of similarity, definition of concepts, and the use of words with general meaning.

Deficient verbal-logical thinking typical of illiterates was apparent in the experiments that necessitated drawing a conclusion from a syllogism. Alexander Luria identified three sources of difficulties occurring in verbal-logical reasoning. The first was *mistrust* of the initial premise if it did not reproduce some piece of visual personal experience, refusal to accept it and proceed from it as an absolutely real basis for further reasoning. The second was the fact that the premise of the syllogism did not have, for the testees, a universal character. It was perceived rather as an isolated message reproducing some pressure. The third was that the syllogism as treated by the testees fell easily into three independent, isolated parts, particulars which did not add up to an integral logical system. The solution of specially devised problems (sums), whose conditions went against actual practical experience, usually remained unsolvable for the testees:

they either refused to start working on them, or said that the conditions could not be correct, that "it can't be like this". Considerable difficulties were produced by the requirement to ask arbitrary (freely chosen) questions, which was intended to make the testees detach themselves from immediate experience and formulate questions going beyond its boundaries. Examination of the illiterates' self-awareness indicated that the questions asked to stimulate analysis of their own personality traits were either not accepted at all, or associated with daily situations of life or material status. This research has convincingly demonstrated that verbal-logical thinking is the latest product of the historical evolution of thinking and that the transition from visual to abstract thinking is one of the trends in this evolution. The evolution of thinking itself is determined, in the final analysis, by the development of social practice and culture.

§ 3. Ontogenetic Development of Man's Thinking

The development of thinking unfolds not only in the evolutionary, historical but also ontogenetic context. The ontogenesis of human thinking has been best analysed with respect to preschool and school age, although, of course, it embraces man's entire life span. A child's thinking is formed in the course of object-related activity, while assimilating social experience. A particular part is played by purposeful influences exerted by adults in the form of training and education. Visual-active, visual-image and verbal-logical thinking of an adult are consecutive stages of ontogenetic development.

The child's very first object-related "actions" (pulling an object, slapping it, feeling it, examining it with his eyes, manipulating one object with the help of another) have a number of important characteristics: 1) when certain practical results have been attained, more properties of a given object and its relationships with other objects become revealed; the possibility of their cognition is presented as a property of any manipulations with objects; 2) a child first comes into contact with man-made objects and therefore begins to cognise man-made reality in entering into object-related practical communication with other people; 3) initially, an adult serves as the basic source and intermediary of the child's acquaintance with objects and the ways of their usage. Socially generated generalised methods of usage are those first pieces of knowledge (generalisations) that the child assimilates from social experience with the help of adults. Apart from practical actions involving objects, specific research

actions are distinguished (the reference to "actions" is only provisional, since a realised goal as an organising element is absent). A child discovers more and more properties of objects, establishes new relationships among them. In the field of object-related actions that have been mastered, a child displays a certain degree of independence. This makes itself felt in the repetition of mastered methods, certain modification (varying) of these methods, the use of an object not only in its intended capacity (e.g., a child would lick a rattle). Of great importance to a child's development is playing games.

A systematic analysis of how children under three cope with practical tasks has highlighted the emergence of rudiments of comprehending the cause-and-effect connections between an action executed with the help of a tool and the resultant movement of the object acted upon. It has also revealed the increasingly strong correlation of an action with its result, the shaping of the child's cognition of interobject structural, dynamic relationships, leading to an adequate mode of activity based on the use of the properties of the object field that the child discovers in the process of practical activity and that hitherto remained concealed. Solution of problems is regulated by emotions, which evaluate an action by its result. An important place is occupied by experience acquired in performing some activity which mediates its further progress. The experiments have made it possible to conclude that a young child's visual-active thinking is not homogeneous but incorporates a number of stages, each having its own level of generalisation of experience gained in the course of activity.

A study of child thinking from the viewpoint of sophistication and improving the means and methods of cognitive activity (transformative-reproductive and classification means) has made it possible to identify several interconnected development trends: practical and executive actions turned into trial and search actions, the very search acts gain in scope. The first stages of the establishment of the child's visual-active thinking have been traced, the type of thinking that only gradually branches off from practical activity and assumes the form of specific trial actions. In one of the experiments, the children were taught to regulate the movements of a toy across an experimental field by pressing a button. When a practical action (pressing the button) was transformed into a research one, the nature of the pressure put on the button changed from strong and lengthy to short and weak. The children themselves no longer regarded the pressing movements as erroneous even if they failed to produce the desired practical result.

As practical transformation of objects proceeds, the child's activity develops a property termed stepwise character, i.e., the children execute the transformations by portions, through consecutive acts. Each act is followed by mental analysis of the changes that have occurred. Random trials and errors are replaced by a system of trial actions. More complex analysis and evaluation of the result of each trial are executed from the point of view of the problem's conditions and from the point of view of expectations. The results obtained are taken into account to an increasing degree in planning the next trial actions. Among the important conditions of the emergence of visual-image thinking is helping the child to form the ability to distinguish between real objects and the models that reflect these objects and allow the child to visualise the hidden aspects of the situation. The evolution of the pre-schoolers' reflection of reality follows both the route of improvement and complication of individual images ensuring generalised reflection of objects and phenomena, and along the line of forming a system of concrete representations of a particular object. The principal development trend of visual-image thinking is the formation of skills necessary to operate with the images of objects or their parts. The basis of such operations is child's ability to voluntarily actualise these images. The images are then embodied in a picture or a model of an object. The technique of operating with images is evolved. There is a variety of forms of such operations. The most complex one is the ability to build new images which substantially differ from the initial ones reflecting the present conditions.

Visual-image thinking plays an important part in the children's understanding of the change and development of objects and phenomena. Five- and six-year-olds already evolve integral pieces of knowledge about the world around them. A hierarchy of the principal and the auxiliary goals is formed in their activity. Images are evolved that reflect the relationships between the performed and the planned actions. The evolution of visual-active and visual-image thinking proceeds in close association with the formation of logical thinking. A characteristic feature of a child's spontaneously shaped thinking is that co-existing in it are the most contradictory ideas and concepts whose development proceeds in a number of directions at once. The sphere of a somewhat vague knowledge is important in making child's thinking more active, as the child tries to get a clear idea of a new phenomenon, to comprehend it in the context of the knowledge he already possesses.

An independent trend in the study of ontogenetic development

of thinking is formed by works dealing with the role of speech in the development of cognitive processes. One may even say that a study of speech, its development, and its place in the shaping of psychic processes is the principal component of Soviet psychology, one that plays a crucial role in the research aimed at understanding the formation of man's entire conscious activity. An interesting psychological and educational experiment was conducted by Alexander Luria and Feodor Yudovich. The subjects of the experiment were five-year-old twins whose speech development was somewhat retarded due to a defect and whose position as participants in the "situation of twins" made speech really unnecessary, thus consolidating the retardation. The children developed only primitive speech woven into direct action, which was matched by a peculiar, insufficiently differentiated structure of consciousness typical of these children: as a rule, they were incapable of separating word from deed, mastering orientation, action-planning and narrative speech, defining the idea of an action, and of subordinating their subsequent actions to this verbal definition. It is for this reason that at the age of five and a half, the twins possessed neither the ability to organise a game following a certain scenario (typical of the children of their age), nor the capacity for productive meaningful activity. Their intellectual operations were very limited, and even elementary classification was beyond them.

The authors of the experiment separated the twins, placing them in different groups in kindergarten. In addition, they systematically taught one of the twins to speak, taught him sensible speech and the habit of using lengthy phrases. The results were unambiguous and significant. The children's speech began to approach that of their peers and acquired new functions. From indicative or expressive speech, interwoven into direct action, it began to turn into narrative speech, and even occasionally planning. The children were now able to define the idea of an action through speech. Three months later, the experimenters noticed that they began to build their games along a definite scenario, developed the ability to perform productive activity proceeding from a defined idea, substantially developed a number of intellectual operations which, not so long before, were in a rudimentary state. The child who was given lessons made far greater headway than the other. For instance, in classifying toys, he grouped objects including them each time into a verbally defined situation: each object was incorporated into a pertinent group and the overall classification distinctly assumed the character of an operation executed "in the imaginative plane". The child

who did not receive special training continued to group objects only in the processes of arranging them; the process had a more direct character. Verbal definitions were given only after the objects had been grouped and were not so much substantiation as justification of the grouping. Other major distinctions between the children were noted when they made comparisons, derived conclusions from a verbal premise, and assessed the grammatical correctness of a phrase. The experiments involving the twins have made a considerable contribution to the study of the concrete influence of speech on the development of psychic processes.

A study of the development of thinking at school age has indicated an important role of the theoretical (as distinct from empirical) generalisations assimilated by children. At present, it can be considered established that when using certain material and methods, even younger schoolchildren display cognitive abilities allowing them to master theoretical mathematical and linguistic knowledge. This, in turn, lays the groundwork for theoretical thinking, a theoretical attitude to the world around them. Theoretical thinking provides the foundation for voluntary self-regulation of intellectual activity. Lev Vygotsky noted that the path towards mastering one's own psychological processes lies "through the gates of scientific concepts". A schoolchild becomes gradually aware of the relationships between goals, means and conditions of activity. Self-organisation of thought processes emerges, above all, in the conditions of joint educational activity, communication within a system of socially useful work. Adolescents develop the ability to put themselves in the place of other participants in joint activity. Cognitive motivation arises.

It has been proved that the opportunity exists to quickly and purposefully foster in a child certain features of his thinking. However, there is always the question of the need and expediency of the use of these opportunities. Visual-image thinking and empirical generalisations play an important part in the life of an adult as well. They are not a transitory stage that must be passed as quickly as possible, be replaced by verbal-logical, theoretical thinking. Alexei Zaporozhets noted with full justification, that the mind of a person who in his childhood did not develop adequate immediate perception of the world around him and visual-image thinking, may later develop lopsidedly and assume an excessively abstract character dissociated from concrete reality. He also stated that to improve the educational process and the programmes of education and upbringing, one must foresee not only what a child of a given age can attain

through intensive training but also the physical, nervous and psychical price he will have to play.

Creating images and operating with them are the levels of development of spatial thinking. The effort to form an image is characterised by specific conditions of image-building (dissociation from the visual foundation of various types), the content of the work to bring forth the images (the types of image transformation), the degree of complexity (the number and character of transformations), and the qualitatively specific features of the methods of image transformation. The level of development of this work *per se* is expressed in its scope, in the degree of voluntariness and awareness, and the type of operating with spatial images. The latter can be of three types: 1) a change in the *position* of the imagined object in space with reference to the other objects or their elements; 2) a change in its structure; 3) a combination of the two. The scope of operating with images also changes, by which we understand the degree of freedom in manipulating an image with due account for the visual basis on which the image was originally built. The following critical points in the development of spatial thinking have been discovered: transition from three-dimensional space to two-dimensional and vice versa; transition from visual representations to conventionally-symbolic ones and vice versa; transition from a fixed reference point (coordinates) to a system with an arbitrarily movable reference point.

Research involving schoolchildren has made it possible to define some of the ontogenetic development trends of their productive thinking. This type of thinking begins to develop with its intuitive-practical component. At the first level, the students reveal the ability to make abstractions and generalise the essential features of the perceived situation without adequate verbalisation of these processes. Gradually, the depth, flexibility, and stability of intuitive-practical thinking increase. At the second level, the intuitive-practical and the verbal-logical components of thinking draw closer together. The degree of significance of the verbalised features and the degree of their generalisation rise. Thought activity becomes more conscious. At the third level, the significance of the abstracted and verbally defined features is enhanced. Gradually, such qualities of productive thinking as independence, depth, flexibility, stability and conscious character are shaped. Not any type of education ensures progress. If it poses too easy or too difficult tasks, which cannot stimulate productive thinking, no headway will be made.

The ontogenetic aspect of the development of man's thinking

should not be reduced to those changes that can be discovered in the thinking of a preschooler or a student. It includes a study of the evolution of man's thinking throughout his lifetime. An important trend of research here is *correlating historical and ontogenetic (individual) development of thinking.* Studying the history of the evolution of psychology, Mikhail Yaroshevsky has defined the basic constant categories of the science (image, action, motive, psychological attitude, personality) and the development stages of deterministic (i.e., directed at a scientific explanation) thought (premechanistic determinism, mechanistic determinism, biological determinism, psychological determinism). Analysed against this broad historical background was the work of Ivan Sechenov, the founder of scientific psychology. A study of the relationship between the historical path of scientific cognition and the individual work of the outstanding researcher has made it possible to state that an individual necessarily passes through the universally human stages of spiritual and intellectual evolution. This came to be known as the "ideographic phenomenon". Ivan Sechenov's work clearly falls into stages as far as his deterministic thinking is concerned: "the Cartesian tendency of thought", "a vivid interest in non-deterministic psychology", "the transition to the positions of mechano-centrism", "assimilation of the principle of biological determinism", "a turn to psychic variables", the "new deterministic explanation of the higher forms of mental activity". Ideographic phenomena in Sechenov's psychological search were discovered as a result of careful analysis of the correlation between the scientist's own ideas and those of his predecessors and contemporaries. "The great generalisation"—that was Yaroshevsky's term for Sechenov's tenet that it was "not consciousness as a world of phenomena unfolding before the subject's inner view but the objectively observed, although cognised in only a mediated form by science, psychically regulated behaviour, became the subject of scientific study." The significance of Sechenov's work is comparable to the contribution to science made by Copernicus. The illusions of introspectionism are similar to the illusion of the Sun's movement around the Earth. In this sense, the feat performed by Sechenov has the same significance as Copernicus' revolution. It has redirected research from the inner "space" of consciousness open to the subject's observation, to psychically regulated behaviour open to objective experimental science. The formation of "great generalisations" which enrich the store of human knowledge and destroy stereotyped ideas (illusions) is the summit of the evolution of thinking in ontogenesis.

Chapter Ten

THE THEORIES OF THINKING

§ 1. Thinking as Association of Representations

Let us now look at the theories of thinking that have been evolved by the principal bourgeois psychological schools and trends, stressing, above all, the structural units of thought activity and the specific aspects of the study of thinking typical of one or another trend.

The first ideas concerning the universal laws of man's psychic life were formed on the basis of the association principle, i.e., the formation and actualisation of ties between representations ("ideas"). This principle provided the foundation for an independent trend in psychology, associationism. The postulates of associationism developed by ancient philosophers were further advanced and gained wide currency in the 17th-18th centuries. The main law of associations was defined as follows: an association is the more strong and accurate the more it recurs. Four types of associations were distinguished: 1) by likeness; 2) by contrast; 3) by spatial or temporal proximity; 4) by relationship (causality, inherence). The laws of association were examined in the works of David Hartley, Joseph Priestly, John Stuart Mill, James Mill and Alexander Bain, to name but a few. Advocates of this trend differed both in their interpretation of the dependence of associations on the connections in the object world and their relationship with the functioning of the brain, and in the interpretation of individual types of associations. The basic idea was, however, the same: association was recognised as the main structural unit of the psychic, and also used as an explanatory principle. The rational was reduced to the sensual, and the subject, his activity, and orientation were not studied.

At that time, psychology of thinking did not yet branch off from the psychological science. At that stage of development of scientific knowledge, the idea of thinking as a specific form of the subject's activity was still non-existent. A random sequence of

images-representations was considered the way of *any* mental process: thinking was always image thinking and a process, a random unregulated chain of images. The development of thinking was believed to be a process of accumulating association. The associationist approach to thinking co-existed with the formal logical characteristic of thinking. Although each association can be viewed from two angles—the formation and actualisation of an already formed association—experimental research into thought activity carried out within the boundaries of associationism involved only actualisation of associations and measuring the rate of consecutive verbal associations. It was maintained that thought processes do not lend themselves to experimental examination. Thinking was supposedly to be studied only through the products of human culture. Since the question of reproducing ideas is a crucial one in the associative theory of thought activity, it is often referred to as *the theory of reproductive thinking*. A special role in thinking belongs to associations by similarity.

The principle of associations as the universal explanatory principle, later provoked a number of serious objections, but association itself is viewed as an indisputable psychological fact. Objecting to the associationist interpretation of concepts, Lev Vygotsky directly connected the simpler forms of generalisation (complexes) with the formation of associations (by similarity and by contrast).

§ 2. Thinking as Action

The field termed "psychology of thinking", which is not the same as the more broadly understood doctrine of thought activity, was outlined for the first time by the so-called Würzburg school, which, in opposition to associationism, regarded thinking as internal action (an act). They launched experimental research of thinking which was, however, very restricted, boiling down as it did to the application of the systematic self-observation method. The testees, usually qualified psychologists, were to report on the processes of their thinking while dealing with tasks involving interpretations of a complicated text or phrase (for instance, they were asked to explain the meaning of the phrase "Thinking is so extraordinarily complicated that many prefer simply to make conclusions"), establishing relationships ("whole—part", "genus—species"), clarifying correlations and relationships among objects and perceiving concrete members of these relationships. But this school also began to look for objec-

tive methods of research. For instance, Narzis Ach created the method of forming artificial concepts.

The following ideas about the processes of human thinking were evolved. Thinking was interpreted as an act of perception of relationships. Implied by the latter was "anything that is not in the nature of sensation", the whole gamut of categorial sytheses, the entire system of categories. Perception of relationships was considered independent to some degree (from the psychological point of view) from perception of the members of these relationships. It was stated that the process of comprehension (i.e., thinking) takes place without substantial support from accidentally surfacing sensual representations, i.e., it is imageless. Among the sensually unperceivable phenomena is not only that which we realise, or what we think about, but also the very essence of the acts of judgement.

It was believed that knowledge develops and that this development starts with the perception of the relationships between the material elements of experience. The process of development of thoughts was understood as the process of perception of new relationships between thoughts, with perception of these relationships derived, to a large extent, from "non-visual knowledge" of earlier thoughts. Thinking was considered the work of the ego performed for the purpose of attaining a certain goal, from which the determinative tendency proceeds. Regarding thinking as the process of problem-solving, researchers made a step towards drawing a line between thinking proper and mental activity (as activity in the mind). Implied by the problem was the conversion of instructions given to the testees into self-instructions, whose functioning determined the selective character of thinking (enhancing some and suppressing other associations). The problem continues to operate even when the testee ceases to be aware of it. Two components were distinguished in it: "the determining tendency" and "representation of the goal". Under the impact of the instruction, when a stimulus mentioned in it emerges, the testee forms a representation of the goal. This representation emanates certain specific influences which are directed at forming a representation of the stimulus which has to appear, the correlated representation. A connection forms between the representations of the goal and the image of the expected stimulus, a connection that gives rise to intention. The major form in which the operation of determining tendencies expresses itself is determinated abstraction (dissociating oneself, under the impact of the problem, from some of the aspects of the stimulus, and perceiving, memorising and becoming aware of

others). It is precisely determining tendencies that impart to thinking its purposeful character introducing order into the thought process. Representatives of the Würzburg school also used the concept of attitude (Set, Einstellung) to designate the states evolved by the testee who has accepted a problem. By mental set, they understood indefinite states of consciousness which were hard to analyse and which regulated the selection and dynamics of the content of thinking in conformity with the problem.

On the whole, the position of the Würzburg school is extremely controversial. On the one hand, it advanced the highly important principle of activity (which was opposed to associations), but this activity was interpreted in the traditionally idealistic manner as a specific kind of work done by the soul. They also began to identify the components of the analysis of activity: task, its determinative influence, activeness, orientation at an object. In fact, they already posed the major problem of regulating mental processes. However, the interpretation offered amounts to an influence of a further undecipherable ego. The Würzburg school levelled a well-thought-out critique against attempts to reduce thinking to sensory images. However it did not make clear what the "non-visual" content of consciousness amounted to. Associating thinking with reflecting relationships, representatives of the Würzburg school interpreted the former as primary perception of relations, as application of apriori categories. Posing the question of the development of thinking, they reduced this evolution to the transition from thought to thought that was completely dissociated from practical activity. Self-observation was recognised as the chief method of research. Viewed from the gnoseological aspect, their position bore a stamp of consistent idealism: "For our part, we shall not only say, 'Cogito, ergo sum', but also: the world exists as we establish and define it." Recognising thinking as an activity in its own right, the Würzburg school not only opposed but also severed it from practical activity, language and sensory images. At the same time, it outlined nearly all the questions which later moved to the forefront in the psychology of thinking: the correlation of external and internal activity, of thinking and language, of thinking and sensory images; the determinative factors of thinking and its selectivity; the problem and the means of solving it. A study of thinking as a problem-solving process has, in fact, become universally accepted in contemporary psychology.

§ 3. Thinking as the Functioning of Intellectual Operations

The ideas advanced by the Würzburg school were carried further by Otto Selz, who understood thinking as the functioning of intellectual operations. He wanted to show the formation of one result of thought activity or another, to demonstrate the function of each stage of intellectual activity in preparing the next stages (the so-called genetic and functional analysis). He also tried to remove the opposition of productive and reproductive thinking in dealing with the reproductive and the productive aspects of integral intellectual activity. In his conception of the process of problem-solving, Selz put the greatest emphasis on the first phase, the formation of the "general problem" as a result of processing the material offered by the experimenter, its main link being identification of the "object relations" among the elements. As a result, a problem complex emerges, in which a) the characteristics of the known factor have been established; b) the place of the unknown quantity has been identified; c) and relations between what is known and what is sought have been identified. Otto Selz saw the crux of the problematic character in the incompleteness of the complex, which pertained either to the component of the complex or a relationship between known components. The formation of a general problem boils down to building a certain scheme in which what is sought is described through the place it occupies in the complex. Selz introduced such an important concept as "anticipation": that which is sought is anticipated. If that which is sought for were the unknown quantity, it could not have become that which is found. That which is unknown is indirectly defined through its relation to the known. The formation of the general problem amounts to revealing the relationships between the known and the sought-for, and the emergence, on this basis, of the anticipation of that which is sought.

According to Selz, the setting of a goal produces actualisation of the more or less general intellectual operations which are suitable for attaining a certain goal. In the simplest case, the task directly actualises already available ready-made ways of solution. In dealing with new problems, intellectual operations are determined by the structure of the general problem and anticipation of the results of these operations. A task is not merely a starting point, it controls and directs the progress of the operations, a person periodically returns to the object content of the task in order to subject it to more thorough analysis. The main intellectual operations are: adding to the complex,

abstraction, and reproduction of the likeness. The various combinations of these operations constitute methods of problem-solving. The first operation, adding to the complex, may include visualisation of a given object. Abstraction means identifying the object's chief characteristics and the relationships among the members of the complex. Finally, a substantial part of the third operation is segmentation of a given object or concept into certain characteristics. Selz stressed the need for finding new methods of solution, although the discovery itself was described as merely the fact that the relationship between the goal and the means between goal-formation and the known method of solution suddenly enters consciousness. In the most complex forms of creative activity, *goal-formation* precedes the discovery of the required method.

Generally speaking, Selz's work was the first in the history of experimental research into thinking to analyse it as a process that consecutively unfolds in time, in which the earlier stages prepare and determine the subsequent stages, and in which the subject repeatedly returns to the problem's conditions. Selz was also the first in the history of psychology to pose the problem of the basic intellectual operations and to try and make a detailed analysis of their composition.

The serious limitation of his approach to the study of creative thinking is that, in discussing the formation of a problem or a problem complex, he essentially reduces it to differentiation or specification of a completely formulated problem. However, the essence of thinking is not so much filling as building problem complexes, indentifying the problem's conditions proper, finding the variables that determine that which is sought, the unknown.

Selz's work has made a strong impact on Adrian de Groot's monograph *Thought and Choice in Chess.* The author intended to produce a generalised description of the structure and evolution of the thought process as the basis for building a theory. It incorporates four consecutively unfolding stages of the process of a chess-player's thought activity: 1) *Orientation,* especially with reference to the existing possibilities. At this stage, the sequences of moves and the general possibilities in specific directions are considered. 2) *Exploration.* The testee tentatively plans rather than explores the possibilities for action. He calculates several simple moves at an insignificant depth, or what, in his opinion, should become the main line. If the result is unsatisfactory, the move is temporarily postponed. 3) *Investigation.* At this stage, more serious and in-

depth search for possibilities takes place, and everything that is sufficiently prominent both qualitatively and quantitatively becomes reinforced. Investigation becomes more purposeful and thorough, more variants at greater depths are played out. 4) *Proof.* The testee tests and sums up, he seeks to get proof. The result is subjectively justified.

§ 4. Thinking as an Act of Restructuring a Situation

A new aspect of thinking was described in the works of the Gestalt psychology school (Max Wertheimer, Kurt Koffka, Wolfgang Köhler, Karl Duncker), a trend in psychology which originated in Germany in the early 20th century and also opposed associationism. A strong impact on Gestalt psychology was exerted by the idealistic doctrines of Edmund Husserl and Henri Bergson, primarily, their thesis on a scrutiny of essences or meanings. The core of Gestalt psychology is the idea that the primary and chief content of each mental process are not individual elements, sensations, but whole formations, configurations, patterns, or Gestalts. The principal object of research conducted within the school was perception, with some of the results applied to the study of thinking. The premise in studying perception was that the visual field falls into the figure and the background. Also analysed were the factors promoting perception of Gestalts: the proximity of individual elements, similarity of elements, their striving towards a regular configuration (closed, symmetrical, definite). One of the main laws of perception is that of "pregnancy", i.e., the tendency of systems emerging in the brain towards equilibrium. The laws originally derived in analysing perception were later extended to cover the study of thinking. Specifically, psychological ideas about thinking amounted to its interpretation as instantaneous perception (insight) of the significant relationships in a problem situation that has not been directly prepared by earlier analytical activity. These relationships are instantaneously perceived as reflection of the objects' sensory characteristics. Research into thinking covered a very broad field, from coping with problems by the higher animals to interpretation of facts of scientific research (e.g., Galileo's discovery).

Systematic experimental research into intelligent behaviour of anthropoids (using a roundabout way, comparing and manufacturing tools), convinced Wolfgang Köhler that the primates display intelligent behaviour of the same type as man. He made an absolute of the similarities and underestimated the qualitative

differences of principle that exist between the behaviour of anthropoids and man's thought activity. He described intelligent behaviour as sudden, independent of previous activity and directly opposite to trial and error. The mechanism itself of "insight" (as opposed to the accidental) solution of a problem is defined as follows: in the organism's optical field, the meaningful situation elements form a single whole, a Gestalt. In being included into this Gestalt, the situation elements acquire new meanings depending on the place they occupy in it (in the manner of sensory structures). The formation of Gestalts out of meaningful situation elements takes place under the impact of certain tension felt by the organism in a problem situation. Much the same tenets were formed on the basis of research (experimental and theoretical) into man's thought activity (Marx Wertheimer, Karl Duncker). The solution of the problem lies in the fact that elements of a problem situation begin to be perceived in the context of a new Gestalt, new relationships. The problem situation is restructured, as a result of which objects display new facets, show new properties. Revealing a new property of an object, made possible by its perception in the context of new relationships, is the essence of the problem's solution which acts as Gestalt, a whole, that determines what concrete steps have to be taken.

Whereas associationism tried to derive the solution directly from past experience (through its actualisation), Gestalt psychology, although not rejecting the significance of previous experience, saw the vital factor in the organisation of the problem's conditions, stressing that the presence of adequate past experience does not yet ensure a successful solution. Past experience may even hamper it by rigidly fixing the function of the objects used in the solution. Some psychologists representing this school used the term "direction" with which they associated the influence of past experience. "Direction" is a general approach to the problem, preliminary orientation, a range of relationships identified as uniting the elements of the conditions of the task. Also used was the concept of the "heuristic. methods of thinking" (analysis of conflicts, goals, and the material).

The work done under Gestalt psychology has made an important contribution to the re-assessment of the subject of psychology of thinking and the methods of its study. A psychologist engaged in the study of thinking was now concerned not only with the thinking of his colleague but the mind of his distant ancestors, the anthropoids, to whom the method of self-observation is not applicable. Experimental research of the

complex forms of animal behaviour included selecting problems with a certain degree of complexity and of a certain type. This alone made it possible to determine the actual capacities of a particular organism. With reference to man, the method of "thinking out loud" was introduced (see Chapter 3), as well as the method of problems containing leads (systematic "prompting"), whose influence varied depending on the stage of problem-solving and which were thus able to act as an indirect indicator of the unfolding process. All this has promoted objective analysis of thought activity. The works of Gestalt psychologists posed a number of questions that had a significance of principle in the psychology of thinking, although their treatment of these questions gave rise to weighty objections. This is, above all, the questions of the specific features of creative (or productive) thinking, the emergence of new ideas in the process of thinking, the part played by past experience in problem-solving, the correlation between thinking and knowledge and the gradual and the instantaneous (the discrete and the continuous) in the process of problem-solving. It is representatives of Gestalt psychology rather than Otto Selz who should take credit for introducing the idea of *functional development* in the psychological study of thinking, and, consequently, in psychology at large. Solution of one problem incorporates qualitatively differing phases, the phase at which the main idea of the solution is found, and the phase at which it is tested or implemented ("functional", and "final" solutions of the problem, according to Karl Duncker). Functional development manifests itself not only in the fact that the process incorporates qualitatively different phases, but also in that the same situation elements have different meanings for the testee at different stages of problem-solving. This is what the phenomenon of restructuring is linked with. This, however, has not been examined at all exhaustively under Gestalt psychology, provoking criticism that sometimes was unjustifiably carried as far as total rejection of the phenomenon of restructuring itself and underestimation of the idea of functional development at large. The problem of functional development is now a central one in the psychology of thinking. Chapters 3-5 of this book review the present state of research into it.

§ 5. Thinking as Behaviour

The psychology of behaviour, or behaviourism, which emerged in the early 20th century, is one of the more influential

trends in modern psychology. John Broadus Watson, one of its founding fathers, believed that the object of psychology is behaviour which should be studied strictly objectively. The main structural unit of behaviour is the link between the stimulus and the response (the famous S—R formula). Attainment of a useful result (reinforcement) is not a necessary condition of the formation of this link. Emerging within complex behaviour are whole series (systems) of links between stimuli and responses.

John Watson interpreted man's thinking very broadly, identifying it with inner speech and even non-verbal communication. The concept of thinking, he maintained, should be expanded by including into it all types of unexternalised verbal activity, as well as all other types of activity fulfilling its function. Should this idea be accepted, thinking would have covered the soundless use of language or any other related material. The concept of "verbal" must in this case be broad enough to embrace the processes resorted to in lieu of vocal speech, such as shrugging or raising one's brows. Thus, according to Watson, *thinking becomes a comprehensive concept incorporating all non-vocal behaviour.*

Watson distinguished three main forms of thinking: a) a simple unfolding of verbal skills (reproducing poetry or quotations without changing the word order); b) solution of problems that are not new but not common either, so that trial behaviour has to be used (attempts to recollect half-forgotten verses); c) solution of new problems which place the organism in harsh conditions, demanding a verbal solution prior to taking an external action. The latter form of thinking, Watson believed, is only a small part of a human being's behaviour which, being stripped of attendant elements, is *identical to that of a rat placed in a labyrinth for the first time in its life.* Man is an animal possessing verbal behaviour. Attaining a conclusion after some reasoning is an equivalent of receiving food after a search in the labyrinth. Skill (any individually learned and retained action) is the central phenomenon as far as psychology of behaviour is concerned. Thinking is closing up with skill (reproduction of poems is also interpreted as thinking). At the same time, behaviour at the phase when the skill has not yet been learned (behaviour of a rat placed into a labyrinth for the first time) is defined as a specific *first* stage in the learning of a skill.

Behaviourism is controversial. Objective analysis of behaviour did not initially include a study of cognitive or orientating activity as mediating the process of formation of a complex

skill. An important idea of the genetic approach is realised through mechanistic form: the process of acquiring new forms of behaviour is viewed as a simple mechanical process of fixing accidentally successful adequate responses. One of the most striking features of behaviourism is its naturalistic quality. Having emerged from the study of animal behaviour, American behaviourism directly applied its methods and principles of research to man. In interpreting the nature of thinking and speech, Watson disregarded the fact that acquisition of language is socially determined and that this process differs qualitatively from the formation of skills. He failed to reveal the complex structure of speech itself and of its development. Interpreting inner speech far too broadly (as all non-vocal behaviour), Watson stressed the link between speech and other psychic functions, but at the same time washed away the specifics of thinking proper. Thinking and consciousness were regarded as a specific type of behaviour, i.e., as real activity of the subject which is accessible to objective study just as the other types of behaviour. Similarly to the locomotor activity, speech was examined as trial, search activity. This highlighted the common features of speech and behaviour and their unity, while the question of the qualitatively specific features of behaviour was not developed.

After John Watson, behaviourism as a psychological school developed in a complicated manner. One of the lines of experimental research into behaviour which directly continued Watson's work is marked by the fact that all its advocates, irrespective of substantial differences on many points, accept the stimulus-response formula as the basic structural unit of behaviour. The second trend views behaviour as a purposeful process, incorporating cognitive (orientating) activity as a mediating link. Within the boundaries of the first trend (Edwin Ray Guthrie, Clark L. Hull, Burrhus Skinner), thinking as such did not get much attention. For instance, the object of Burrhus Skinner's analysis is "verbal behaviour", which is regulated by the general laws of operant learning studied by experiments involving animals. The second trend (Edward Ch. Tolman) was the product of the interaction of the original version of behaviourism and Gestalt psychology. Tolman recognises the need to analyse factors mediating external behaviour, or the "interfering variables", whose function is performed by "cognitive processes". Using modern terminology, one can say that Tolman has advanced the cognitive theory of behaviour (the S—S theory). The main points of difference between the two theories (S—S and S—R)

make themselves felt when the following three tenets are discussed:

1. How does an integral behavioural act arise; what acts as the integrator in structuring integral behaviour? Representatives of the first trend view as integrators of consecutive behavioural acts the organism's responses or movements, i.e., peripheral changes in it. For this reason, this theory is sometimes called "peripheral". Advocates of the cognitive theory (S—S) view the central processes as integrators (memory, "expectation", attitude or set). This theory has been dubbed central.

2. What is the result of learning? The first opinion holds that it is acquisition of a skill as a certain fixated sequence of movements. The second opinion is that the most important result of learning is the formation of a certain "cognitive structure" (i.e., reflection of a situation).

3. How does the organism behave in new conditions, coming up against a certain problem? What is the part played by past experience in coping with new problems? Advocates of the first theory consider past experience decisive. Faced with a new problem, the organism uses, first and foremost, old, earlier shaped skills responding to the familiar elements in the new situation, to that which cropped up in earlier situations. If the application of the old skill fails to bring the desired result, a behavioural pattern emerges which is known as trial and error. The second theory (S—S) stresses that even in the presence of adequate past experience there is still no guarantee that the student will use it to find a solution. The solvability of a problem is determined, above all, by its structure or organisation, upon which actualisation of the organism's past experience and understanding of the meaningful relations included into the problem depend.

The cognitive theory of behaviour uses such concepts as "cognitive structure", "expectation", "readiness", "goal", "meaning", "relation of signs to meanings", "cognitive plan", "cognitive predisposition". The process of thinking is not distinguished as an independent one. Careful analysis of what is actually meant by cognitive processes shows that the matter at issue is usually the phenomena of *perception* ("stimulus as it is perceived by the organism", "the state of need as it is perceived by the organism"), and memory ("expectation as actualised readiness"). Most of the experiments prove the fact of the existence of "cognitive structures" and the important place they occupy in behaviour, but they lack an analysis of how new cogni-

tive structures are generated. At best, factors are specified affecting their formation (e.g., the role of motivation). The cognitive theory of behaviour is still naturalistic. Attempts are made to prove that at the human level, *the same* laws operate (for instance, the formation of "expectation" at the level of "verbal behaviour"). A "goal" is the effective result of behaviour (for instance, "feeder"). Goals as specifically human formations are not singled out. "Meanings" are the signal values of irritants, orientating points, not socially generated meanings assimilated by the individual.

A new approach to the study of thinking was expounded by George A. Miller, Eugene Galanter and Karl H. Pribram in their book *Plans and the Structure of Behaviour,* which they called subjective behaviourism. The authors named their theory of behaviour T-O-T-E (from Test-Operate-Test-Exit) and opposed it to the S—R and S—S theories, which they consider limited. The structural organisation of behaviour is understood in the following way: an influence upon a system—testing it against some past states. Depending on the result of the test, the organism either reacts in a certain way if the influence matches past experience, or displays search and orientating reactions if it does not. The results are evaluated by the organism, and only after attaining some satisfactory result, does the final action take place. "The action is initiated by an 'incongruity' between the state of the organism and the state that is being tested for, and the action persists until the incongruity (i.e., the proximal stimulus) is removed". Thus, T-O-T-E in fact insists that the structure of each type of activity includes the comparison of the outside influence against the state of the system itself, and, second, a special process of evaluating the results attained by the system of actions.

Specifying their understanding of the structure of behaviour, the authors introduce the concepts of "image" and "plan". "Image" is knowledge, past experiences mediating behaviour (and not simply "sensual representation"). "Plan" is defined as an indication as to how to attain some result or, in a more complete form, as any hierarchical process in the organism that can regulate the sequence of operations to be performed. Miller, Galanter and Pribram criticised Tolman's cognitive theory of behaviour, believing that the cognitive processes Tolman and others have postulated were not, in fact, sufficient to do the job they were supposed to do. Plans are present in any psychic processes. In coping with intellectual problems, two kinds of plans are realised: a) systematic plans,

when large-scale exploration is performed that tests all objects; b) heuristic plans, reduced exploration in the course of which only part of the objects or their characteristics are tested.

The limitations of the subjective behaviourist approach to the description of man's thinking is that the latter is regarded as, in fact, a "process in the organism", since the concept of "plan" is used as the main one, and plan, under this doctrine, is present in any behaviour of an organism. "Removal of incongruities" is actually an adaptation process. The theory of behaviour at large and thinking specifically remain naturalistic. No analysis has been undertaken of the generation of new plans, the generation of criteria making possible a selective (as distinct from a systematic) search. "Images" and "plans" are thus divorced from the motivational-emotional sphere.

§6. Thinking as a Motivated Process

The problem of motivation of human behaviour was brought into prominence by psychoanalysis, above all Sigmund Freud and his followers. It was believed that human activity and behaviour rest on two principal, or basal motives: the sexual urge (libido) and aggressiveness. The motives governing the adult and his behaviour are a product of the transformation of infantile motives. The concepts of sex and aggressiveness are interpreted very broadly: for instance, with reference to a child, sexuality is supposed to manifest itself in the pleasure derived from stimulating the sensitive body areas. All positive emotions that arise in consequence of this are interpreted as an expression of innate sexuality postulated as a fact. Early expression of aggressiveness are bites and fights. It is supposed to mount with age. The principal motives are unconscious and are manifested in dreams, slips of the tongue and other mistakes (parapraxes), and symptoms of illnesses (especially neuroses).

Dreams are viewed as a version of involuntary image thinking. Two types of dreams exist, "child dreams" and "symbolic dreams". The principal characteristic of "child dreams", which grown-ups may also have, is the direct and clearly traceable link between man's frustrated wishes and motives and the images that arise in sleep ("a person wanted a candy but was refused, so he dreams about it and about the process of eating it"). At the moment of waking up, a person experiences the sensation of partial satisfaction of the need. Symbolic dreams have a more complex nature. In them, images are not immediately and easily linked with the motive, such a link has to be uncovered. Wide

currency in psychoanalysis has been gained by the method of free association, which also highlights some of the features of man's thought activity. Thus, involuntary image thinking and free association are regarded by psychoanalysis as major areas in which unconscious motives manifest themselves. The bond between images and motives may have a variety of forms. In thought activity, too, "errors" may occur.

Freud is also the author of a work which can be regarded as belonging to the psychology of thinking, *Wit and Its Relation to the Unconscious.* Wit is a sign of creative thinking; essentially, it is generation of contextual meanings. Wit is always based on unconscious primary motives. The theory of sublimation also has a direct bearing on psychology of thinking: according to this theory, creative work (and its products in the form of culture) arise as a result of limitations imposed on the opportunities for satisfying the primary needs and give rise to a roundabout "sublimated" way of gratifying the very same needs. Among the questions dealt with by psychology of thinking is that of becoming conscious of the motive. In classic psychoanalysis, unconscious motive does not preclude the possibility per se of realising thought activity with regard to it. However, consciousness of this motive may be not genuine but false (the phenomenon of rationalising the motive). Modern psychoanalysis stresses that even when essentially reflecting motivation, man does not always realise its importance.

In passing judgement on the psychoanalytical approach to the study of motivation of thinking, one must remember that the general theory of motivation it advances has its limitations, as does the analysis of the links between motivation and thinking. The former is apparent in the biologising, individualistic approach to motivation, and the latter, in the fact that thinking (dreams, wit, creative work) are interpreted as merely a field in which motivation finds an expression, while no study is made of the impact of motivation on the organisation and structure of thought activity. The theory of creative work as sublimation of biological motives has not been scientifically substantiated either. Criticism has been evoked by the method of interpreting dreams, i.e., a study of the manifestion of motives in man's image thinking, as well as a view of the relationship between the conscious and the unconscious as strictly antagonistic. Nevertheless, one must not forget the valuable aspects of psychoanalysis: awareness of the importance of the problem of motivation, an analysis of the ways in which it finds expression in thinking, awareness of the significance of the unconscious

in thinking, an attempt to identify the specific features of the unconscious as compared to those of consciousness (neglect of contradictions, the non-temporal nature of the unconscious).

Adjoining psychoanalysis is Bleuler's doctrine of autistic thinking; however, he did not fully share Freud's views. Autism is predominance of inner life, withdrawal from the outside world. Ordinary dreams, day-dreaming, mythology, prejudices, schizophrenic thinking are all manifestations of autistic thinking, in which thoughts are subordinated to affective needs. There is no clear-cut dividing line between autistic and ordinary thinking, since the latter is easily penetrated by autistic, i.e., affective elements. Autistic thinking uses concepts for conjuring images of unfulfilled wishes as realised ones. Realistic thinking builds adequate pictures of the outside world; its purpose is to get at the truth. Autistic thinking pictures that which corresponds to the affect. An important idea is that of the existence of autistic and realistic satisfaction of one's needs. It is only at a certain stage of individual development, that the autistic function joins the realistic one, and henceforth develops alongside it. A better opportunity emerges for the influence of emotionally coloured engrammes from the past and emotional representations pertaining to the future. Anticipation of pleasure induces reflection prior to taking action, it prepares action and releases energy. Autism is associated with exercising mental abilities. Autistic thinking, Bleuler believed, develops alongside realistic thinking and contributes as much to the creation of cultural values as to the breeding of superstitions, delusions and psychoneurotic symptoms. Bleuler's doctrine is among the most complex mechanisms of the need-emotional regulation of thinking, and highlights its significance. It conveys the universally known distinctions between the "dreamer" and the "realist". However, it is not free from the vice of opposing the reflective (realistic) function of thinking to its motivation by the need-emotional sphere. At present, it can be considered proven (see Chapter 4) that even an adequate, truthful reflection of reality is a product of activity which is always regulated by the need-emotional sphere.

Another major doctrine in the psychology of thinking is the *cognitive theory of motivation.* It proceeds from motive to cognition and not the other way round, as used to be the case in the original psychoanalysis, which described the way "from motive to cognition". In this context, meant under the cognitive process are the plans evolved by man (conscious plans), the goals that he sets himself, expectations of which he is aware,

and the risk he takes consciously. The core of the theory is the idea that motivation of human behaviour is shaped in conformity with cognition. Studied under the cognitive theory of motivation is the classic research into the level of aspirations and into achievement motivation. This type of motivation is usually described as the tendency to define one's own goals proceeding from certain qualitative standards of the product or of activity itself. Achievement motive is diagnosed by certain characteristics of the subject's cognitive activity (phantasy). As distinct from the classic psychoanalytical research, the cognitive theory of motivation studies not only cognitive activity in the form of dreams but also that cognitive activity which can be initiated by the experimenter in the conditions of laboratory experiment. The achievement motive, when it is present, reveals itself in the operation of the subject's imagination in a manner which may leave him unaware of its emergence. In other words, describing an outside object or its representation in pictorial form, a person also imparts information about himself without being aware of it. The experimenter's task is to single out that part of the story that pertains to the subject, i.e., manifestations of the motive. As the theory of achievement motivation advanced, the actually operating motive came to be treated as a product of the interaction, integration and even competition of the two tendencies, fear of failure and the desire for the pleasure yielded by success. Cognition acts as polymotivated activity. The choice or preference of some alternatives in a situation on the basis of cognitive analysis is also interpreted in the context of the cognitive theory of motivation. Adjacent to it is research into the hierarchical arrangement of man's motivational sphere. Stress is laid on the dependence of a situationally evolved hierarchy of motives, on the way in which a person cognises the situation and on his expectations and ideals.

A special place is allotted to the need to correct the imbalance, or dissonance between the various motivational tendencies, attitudes, beliefs and ideals. This approach has been realised in the theory of cognitive dissonance. Its author is the U.S. psychologist Leon Festinger, who concentrated on one but typical case of the emergence of dissonance. Man often finds himself in a situation when one of the mutually exclusive alternatives has to be chosen. A psychologist is interested not only in the processes preceding the choice but also the process that unfolds after an irrevocable choice has been made. Having made it, a person may realise that it was a mistake. In such

situations, attempts are made to minimise the significance of those constant messages which go against, clash, create a dissonance with the choice that has been made.

Another important trend in the study of motivation deals primarily with the motive of *self-actualisation.* Research into this field was begun by Carl Jung, Freud's pupil, and analysed in detail by Abraham Maslow, a representative of "humanistic phychology". The need for self-actualisation is the most recent product of the evolution of the motivational sphere but, having emerged, it begins to play the leading role. Among the typical features of self-actualising personalities are, according to Maslow, those which pertain to thought activity: "effective perception" (the reference is to "comprehension", not to perception in the narrow sense of the word) of "reality and a comfortable relationship with this reality", "spontaneity and constant freshness of understanding of things", "a sense of humour" and a "tendency towards creative work". The highest manifestation of self-actualisation is man's feeling of the fullness of his existence.

Let us now consider some of the more general features of the *cognitive theory of motivation.* An important question is: what exactly is meant by "cognition" in the framework of this theory. Let us remind the reader that cognition implies plans, goals, expectations and a tendency toward risk. The limitations typical of the classic research into the level of aspirations in dealing with goals and goal-formation is that essentially the subject's entire cognitive activity and the processes of setting new goals are to a large extent reduced to the acts of choosing from among a certain number of tasks. The formation of the goal on the basis of the chosen task and the process of its accomplishment (the search for solution) are not analysed. Cognitive processes are brought down to relatively elementary forms. In examining achievement motivation, a full-scale analysis of the subject's cognitive activeness is also not made; at best, its final productivity is recorded. Research into so-called cognitive dissonance does not contain a detailed examination of the processes of assessment and re-assessment, acceptance or non-acceptance of the information which enters into conflict with the subject's strivings. This means that one of the principal features of the cognitive theory of motivation as developed by modern psychology abroad is the study of fairly elementary forms of cognition in the context of motivation, and the interpretation of cognition itself as, at best, an "arena" where the motive can express itself, with the func-

tions of the motive in cognitive activity remaining unexamined in any detail. Consequently, although setting the important problem of "cognition and motivation", the cognitive theory of motivation does not explicitly deal with it. The concept of self-actualisation does not offer an analysis of the cognitive processes proper either. Self-actualisation is interpreted in an abstract manner, with the accent placed on man's individual self-expression. What is important, however, is the direction in which self-actualisation unfolds, whether it is achieved by depriving another person of a chance for self-actualisation, i.e., the crucial point is the attitude to social values. Opposed to the abstract doctrine of self-actualisation is the concept of the all-round development of the personality as a product of social and historical conditions and the subject of the subsequent transformation of these conditions.

§ 7. Thinking as a Bio-Logical Process

A major trend in research into thinking is the work of Jean Piaget and his followers. Piaget operated with the concept of intelligence, not "thinking", referring to psychology of thinking only as to a certain interpretation of this phenomenon. It is derived primarily from the Würzburg school, of which he was critical. Defining intelligence, Piaget regarded its interpretation as "psychic adaptation to new conditions" (Edouard Claparède, William Stern), as an insight (Karl Bühler, Wolfgang Köhler). As for himself, he identified intelligence as progressive reversibility of mobile structures and believed that it was a state of equilibrium towards which all consecutively arranged cognitive and sensorimotor adaptations gravitated, as do all assimilative and accommodative interactions between the organism and the environment. Naturally enough, these definitions require an explanation. One of the traditional ways to reveal the specific features of thinking is comparing it to perception, i.e., another form of cognition. This is the route followed by Jean Piaget: perception is knowledge we acquire about objects or their movements through actual direct contact while intelligence is *knowledge* that exists only when, in the process of interaction of the subject and the object, deviations of various kinds have occurred, and when the spatial and temporal distances between them increase.

One of the premises is the distinction between the object and the subject. The former is some external invariant reality existing outside the subject. The latter is an individual regard-

ed from the viewpoint of action. Certain relations evolve between them. Piaget's theory includes two main components: the doctrine of the *functions* of intelligence, and the doctrine of the *stages* of its development.

In the most general form, intelligence is viewed as further development of some fundamental biological characteristics, fundamental in the sense that they are an integral part of life. These include adaptation and organisation. In turn, adaptation incorporates two mutually dependent processes termed assimilation and accommodation. Organisation and adaptation are the two main functions of intelligence, or functional invariants. The invariant characteristics are regarded as properties of *biological* functioning at large. The organised character of intellectual activity means that in each type of the subject's activity, one can single out a certain whole and a certain something that is incorporated into this whole as an element possessing certain relations with the whole. The meaning of the term "assimilation" stresses the fact that during his cognitive activity, the subject reproduces some of the characteristics of the cognised object. "Accommodation" is the process of the cognising subject's adaptation to the various demands of the objective world. What happens is not only the subject's reproduction of iindividual and integral characteristics of the cognised object. The subject himself changes in the course of cognitive activity. Piaget refers to the cognitive experience that has been accumulated by a given person prior to a certain time as the cognitive structure. One of the features of the functioning of man's intelligence is that not any content received from the outside world can be assimilated, but only that which corresponds, however roughly, to the individual's internal structures. In describing the functioning of intelligence, the term "schema" is used among the basic ones. A schema is a cognitive structure relating to a class of similar actions following a certain sequence that is a closely knit whole, in which the behavioural acts constituting it are closely interrelated with one another. The concept of schema gives a more concrete character to Piaget's concept of the organised nature of intelligence. Another basic concept of Piaget's theory is "equilibrium", in the sense of balance between assimilation and accommodation. The two types of the functioning of intelligence form the states of balanced and imbalanced equilibrium.

The doctrine of the stages of mental development, to which most of Piaget's works are devoted, distinguishes four such stages: 1) the sensorimotor period (from birth to the age

of 2); the pre-operational period (from 2 to 11); 3) the concrete operations period (from 7-8 to 11-12); 4) the formal operations period. Intelligence begins to develop even *before* the child learns to speak. One of the first signs of his intellectual activity is tracing the future results of movement (as the elementary form of locomotion). The establishment of the elementary purposeful locomotor acts is the establishment of genetically initial forms of intelligence. The main characteristic of concrete operations (e.g., classification) is attachment to objects. Formal operations are, as it were, dissociated from the objects. Developed intelligence is viewed as a system of operations. An *operation* is an internal action which derives from external, object-related action. As distinct from the latter, operation is curtailed action. It does not involve real objects but images, symbols or signs, and is organised into a system in which operations are balanced by the quality of reversibility (meaning the presence of a symmetrical and opposite operation which, proceeding from the results of the first, restores the original situation or initial position). The development of the child's thinking is understood as a sequence of the stages described above, which are associated with definite ages, although in more ways than one. Training may either accelerate or slow down development processes.

Piaget's theory is one of the most thoroughly developed and generally accepted. Its attractive sides are the genetic approach in dealing with general psychological problems, a thorough development of the "clinical" method of research, a stress on the fact that intellectual activity not only reproduces the features of objects but engenders a change in the subject himself, a change which determines the future opportunities for cognising new objects, the attempt to link up intelligence with a broader class of life activity. However, the theory also has its limitations. Seeking to identify the basic characteristics of intelligence, Piaget used, primarily, biological and even physical concepts (e.g., equilibrium). He described the development of the structure of intelligence in mathematical and logical terms, which can hardly convey the new quality that emerges at the level of *human* intelligence as distinct from what is to be found in biological, physical and abstract logical and mathematical systems. The concept of intelligence as an organised whole is sound but so general that it does not even differentiate between intelligence and behaviour aimed at getting food. Man's intellect is

represented as a *bio-logical* function. The theory of the development of intellect attaches overwhelming importance to self-sustained movement, and underestimates the significance of outside formative influences. The periods of the development of the operations are too closely associated with age. The work of Pyotr Galperin and his associates has shown that specially organised purposeful training may help even the elder pre-schoolers shape formal operations (classifications). Jean Piaget's theory has not developed the issue of functional development, leaving ontogenetic and functional development uncorrelated. Formal-logical thinking as the highest form is interpreted in a limited manner in ontogenesis, since in adolescence, it reaches "the final equilibrium".

§8. Thinking as a System of Information Processing

In the mid-20th century, another interpretation of thinking was evolved, an outcome of the headway made by computer technologies and software. The term artificial intelligence began to crop up. Allen Newell, Herbert Simon, Joseph McCarthy and Marvin Minski, to name but a few, published their research in this field. The comprehensive inter-disciplinary problem of expanding the capabilities of computer facilities was to exert a strong impact on the development of the psychological science. For example, George A. Millers', Eugene Galanter's and Karl H. Pribram's theory of behaviour originated as a result of transferring the concepts of cybernetics to the study of behaviour, making an absolute of the analogy between the computer (and its programme) and the organism (T-O-T-E). "Plans" were identified with computer programmes, while the question of the specific features of planning by man as distinct from computer programmes was not even raised. Psychology at large was declared a science of information processing. The information theories of perception, attention, memory, emotions and personality were developed. Presentation of theoretical psychological knowledge as a computer programme was supposed to be a sign of their genuinely scientific character. Thus, Peter H. Lundsay and Donald A. Norman view man's organism as an active processor of information eternally striving to sum up and interpret the incoming sensory data and to interpret and reproduce the information stored in its memory through a variety of algorithms and strategies. A new trend, cognitive psychology, emerged in the West.

Ulric Neisser wrote by way of explanation of the emphasis

on the study of cognitive processes and of the specifics of cognitive psychology's approach to the classical problem of cognition: "There were several reasons for this turn of events, but the most important was probably the advent of the computer. This was not just because computers allow one to conduct experiments more easily or analyse data more thoroughly, though they do. Rather, it was because the activities of the computer itself seemed in some ways akin to cognitive processes. Computers accept information, manipulate symbols, store items in 'memory' and retrieve them again, classify inputs, recognize patterns. Whether they do these things just like people was less important than that they do them at all. The coming of the computer provided a much-needed reassurance that cognitive processes were real; that they could be studied and perhaps understood. It also provided a new vocabulary and a new set of concepts for dealing with cognition; terms like *information, input, processing, coding,* and *subroutine* soon became commonplace. Some theorists even maintained that all psychological theories should be explicitly written in the form of computer programs. Others differed, and continue to differ, but no one doubts the importance of the computer metaphor for contemporary psychology. As the concept of information processing developed, the attempt to trace the flow of information through the 'system' (i.e., the mind) became a paramount goal of the new field. (I stated this goal explicitly myself, in a book called *Cognitive Psychology).*"

Cognitive psychology is marked, on the whole, by a synthetic attitude, the wish to overcome the limitations of the isolated interpretation of thinking, perception, memory, and attention. In describing the field of cognitive psychology, Neisser also pointed to problem-solving. Peter H. Lyndsay and Donald A. Norman wrote about "thinking" and "problem-solving". But research into perception and memory obviously dominated. The general definition of cognitive activity reads: "Cognition is the activity of knowing: the acquisition, organization and use of knowledge." "Omitted" in it is a major link, generating new knowledge. The term "acquisition" can be interpreted as acquisition of ready-made knowledge, which means that the overall idea of cognitive psychologists, i.e., the building of an integral theory of cognitive processes, remains unrealised. Cognition is severed from the motivational-emotional sphere of both the organism and the personality.

Understanding of thinking as a system of information processing has certain limitations: it does not draw a dividing

line between the cybernetic data processing systems and psychological systems proper. It does not study the *subjective* determination of thinking, meaning-and goal-formation, the emotional-motivational regulation of thinking, the correlation of the conscious and the unconscious elements in thought activity, the types of generalisations and the evolution of thinking. However, these issues are, in our opinion, of principal importance in a psychological study of thinking. Representatives of cognitive psychology believe that modelling events in one's mind is the essence of thinking. However, the very modelling process remains obscure, as do the important relationships between the categories "modelling" and "reflection". It is, however, considered proven that mental reflection of a problem situation and the very search for solution differ qualitatively from similar processes as executed by the computer, which renders the very analogy limited in the extreme. Theoretical and experimental psychological research has made it possible to conclude that writing a computer programme does not yet mean creating a theory of man's thinking, or of behaviour and cognition at large, and that the principal purpose of *psychological* (as opposed to cybernetic) research into thinking is to analyse the specific features of man's thinking as distinct from the operation of computer programmes, and that the "presence" of processes and mechanisms of cognitive activity in a computer programme can by no means be used as a criterion of a scientific, materialistic understanding of the nature of these processes and mechanisms. This approach would mean erroneously identifying the materialist and the mechanistic approaches. Failure to distinguish between the psychic and the information processes is typical of the new form of natural-scientific materialism that has evolved in the wake of the scientific and technological revolution and is associated with the building and use of computers. An explanation based on drawing an analogy with the principles of computer operation can be termed computer, or information determinism. The alternative, "the machine or the mind" current in scientific writings is nothing but an expression of the old differences in the approach to the analysis of psyche from the position of mechanistic materialism and idealism. This alternative was indeed the only one prior to the emergence of dialectical and historical materialism, and it remains the only one in psychology developing outside Marxism, but, naturally enough, it does not have this significance for Marxist psychology.

CONCLUSION

Applied psychological research of thinking is extensive enough to be written up independently. Therefore we confine ourselves to a brief description of the various fields of social practice where psychological knowledge about thinking is finding use. Applied psychological research can be of at least two types: a) research carried out within one of the established branches of the psychological science; b) research associated with the solution of a complex scientific and practical problem and bringing together the studies pertaining to different branches of psychology and even running ahead of them (this type of research can be provisionally termed general psychological applied studies as distinct from general psychological theoretical and experimental studies). Let us, for the time being, concentrate on the former.

Distinguished within *industrial psychology* as a special section is occupational studies. Against the background of increasing intellectualisation of labour, psychological analysis of problem-solving within the structure of labour activity is becoming increasingly important. Various types of intellectual labour exist. Psychological literature is working on the problem of technical thinking as a specific type of intellectual activity. Occupational studies still retain as basic Lev Vygotsky's idea that industrial psychology should develop the problem of thinking on the basis of experimental research. In studying the various types of labour activity, the types of problems tackled by man are identified and systematised, intellectual activity is classified and, on this basis, the intensity of intellectual work and capacity for it are evaluated. The boundaries of rational formalisation of intellectual work are defined.

Drawing on the general psychological concepts concerning goal-formation, occupational analysis of an accountant's work has been made for the audit of accounts. It has been shown

that the final goal in this type of activity (timely, accurate and correctly drawn-up accounts) presupposes singling out a number of concrete goals, which may be either formalised, i.e., described in precise formal terms, and non-formalised, i.e., formulated in general, insufficiently precise terms. The work of compiling and auditing accounts includes a multi-level hierarchy of preset requirements registered in instructions, on the basis of which goals are defined. An imprecise non-formalised description of a requirement allows for setting, on its basis, of a variety of goals and predetermines a diversifiied result of thought activity. The following types of goals have been singled out: multiple-and single-purpose, preset and new, complete and emergent, formalised and non-formalised. Also described were the ways of goal-formation: accepting a ready-made single-purpose goal, transformation of a general multiple goal into a concrete goal. The researchers defined the objective and the subjective factors affecting the process of goal-formation; the parameter of goal-formation was used to analyse the changes introduced by scientific and technological advances into an accountant's work. Another study that analysed the process of 'accepting a goal in labour activity, i.e., definition of a concrete goal on the basis of external requirements, has shown that it is possible to *forecast* the productivity of a person's action aimed at attaining a goal. Important areas where psychological knowledge about thinking can be applied is encouraging and organising creative work (engineering design, scientific research, management). An important and urgent task is that of studying economic thinking, which manifests itself in creative search for methods securing the optimal national economic results at minimum expenditure.

In *social psychology,* a substantial place belongs to the study of the psychological conditions of joint thought activity. Social roles typical of scientific research groups ("Generator", "Critic", "Executor") have been identified, and it was shown that researchers prefer to cooperate with persons whose qualities as scientists complement their own. Pair complementation in scientific research has been analysed. It may involve specialisation (each of the two scientists complementing one another, having a better knowledge of a certain relevant field), methods of work (theorist and experimenter), inclinations and talents (generation of ideas and the ability to set them down in writing), cast of mind and character. Among the conditions required for scientific collaboration are community of principal interests, community of scientific principles

and psychological compatibility. Knowledge about thinking is essential in organising interpersonal cognition and communication, and influencing the personality. Psychology of thinking merits attention in developing topical psychological problems of propaganda work and public opinion polling.

Developmental and educational psychology have traditionally stressed testing mental development as a component part of the personality's all-round development, the possibility of purposefully influencing this development, and the nature of abilities and talents. Productive thinking is viewed as the basis for the ability to learn, as the capacity for acquiring new knowledge, as intellectual (mental) ability to be educated. An indicator of the mental ability to learn are independent achievements in coping with new problems ensured by productive thinking. Individual features of child thinking, which are formed in the course of activity, become fixated and consistently manifest themselves in carrying out activity that necessitates thinking. The mental qualities that evolve affect the choice of parameters essential for the solution of a given problem, the level of their generalisation, the scope of application of new knowledge, the rate and ease of their assimilation, and how quickly headway is made in learning. These parameters are all components of the ability to learn.

Soviet writings consistently uphold the theory of the decisive, determinative role of education in the development of schoolchildren's thinking. The effect of the environment on the development of productive thinking should be evaluated not only for all children of a given age, or a whole group of children, but for the various psychological types as well. The same conditions may be best for some children, and less favourable for others. Research into productive thinking as the basis of the ability to learn has shown that not only a more individualised but also a more differentiated approach to education is desirable, above all, with respect to the extreme categories of children, those whose mental development is higher than average, and those who are mentally retarded. Psychologists recommend the expansion of the network of forms and schools with extended curricula and higher standards set to the children's independent thinking (of the physics and mathematics schools type), and to make a broader use of special methods of teaching retarded children. A major trend in improving educational practices is enhancing the share of theoretical knowledge as the basis of shaping theoretical (as opposed to empirical) thinking. There has recently been increased interest in the reflexive

aspects of thought activity as a factor of its productivity. A study, and awareness by the children of the specifics of the solution of intellectual creative problems reduces the number of cases of inadequate localisation of the search zone in dealing with mental problems, thus increasing the number of efficiently solved ones. In the context of educational psychology, the principal goal is to develop the psychological foundation of fostering scientific thinking. This implies the ability to form independent judgements concerning complex phenomena, including social ones, to grasp the link between short-term and socially significant long-term goals, and to conduct well-argumented polemic.

A study of thinking in the context of individual branches of psychology possesses more than merely applied value; it promotes a deeper understanding of thinking thus enriching the general psychological theory of thinking. Pathopsychological research has made an important contribution to substantiating the nature of thinking as an activity, i.e., a motivational, personalised phenomenon. General psychology, however, does not merely mechanically sum up and record the results accumulated by its branches. The incoming information must be *generalised,* which implies not only recording successes but helping to overcome the inevitable limitations of each individual aspect of the study of thinking. General theoretical and experimental psychological research must *run ahead* of the developments in the individual branches of psychology and serve as the foundation for the advancement of new approaches. An example of this type of relationship is a study of goal-formation. Initially launched in the general psychological field it has promoted research into goal-formation in pathopsychology, industrial psychology, social psychology and educational and developmental psychology.

General psychology of thinking (just as general psychology at large) is linked to practice not only in a roundabout way, i.e, through individual branches (industrial psychology, social psychology, medical psychology, educational psychology) but also directly. The point is that when a need arises to research a major, complex scientific-technological, medico-biological or socio-economic problem, the "order" placed with the psychologists is couched in "general" terms, it is rarely segmented into problems addressed exclusively to experts in any particular branch of psychology. What is more, life often advances problems that branches of psychology are not equipped to cope with on their own, that demand additional fundamental

research as a condition of getting practical results. It is probably expedient to single out not only the general theoretical problems and general problems of experimental research but also *general applied problems* as structural components of general psychology.

In *medical psychology,* disorders of thinking have been traditionally regarded as major diagnostic indicators. It has been proved that patients with malfunctioning parietal and occipital lobes, and with mulfunctioning frontal lobes demonstrate different types of distortions of the problem-solving process. The first group has difficulty uniting the elements of consecutively received information into simultaneously perceivable patterns. They fail to grasp the logical and grammatical definition of the conditions ("so many times more than", "larger by ..."). A link in the activity unfolds that leads to conscious comprehension of the problem's conditions, which the patients come to grasp only through a complex consecutive chain of operations. The patients with their frontal lobes affected displayed a phenomenon described as "disintegration of the predicative (meaningful) structure of the problem". While retaining the components of the problem's conditions with a fair degree of accuracy (only occasionally did they simplify the relationships conveyed by them or change them under the impact of earlier evolved stereotypes), these patients found it most difficult to retain the requirements of the problem, so that the overall problem, which lost its semantic structures assumed the form (as they saw it) of a message concerning the set of data that were not subordinate to any requirement which could help organise these data into a solution. Special research has shown that the pathology of purposeful activity in subjects with afflicted frontal lobes can amount to supplanting the heuristic organisation of the search by the more primitive process of going through a range of possibilities.

Diagnosing disorders of thinking is an important goal of pathopsychology, which has singled out three basic types of disorders. The first, disorders of the process of generalisation, has two forms, a drop in the level of generalisation and distortion of the process of generalisation. The second form, disorders of the "logical thinking", embraces superficial "flights" of ideas, inconsistent judgements, "getting bogged down". The third form of disorders are those of the purposeful character of thinking; they make themselves felt in distortions of critical attitude, mutual interference of planes of thinking. A study has been made of disorders of the selectivity of actua-

lisation of past experience in problem-solving. Recently, considerable emphasis has been laid on the application of the results of general psychological research into goal-formation to diagnosing its disorders. In developing the principles of psychotherapeutical influences, one must never forget that man's thought activity is exceedingly complex.

Psychology of sport studies the sportsman's thinking. It is concerned with all sports, but particularly with the "intellectual" kind. There exists an extensive programme of the study of chess-players, which forms a component part of getting them into shape for the game. It includes an analysis of the style of their game, observation of their facial expressions and body language, measuring the time they take to complete the game and to think out individual moves, a study of the typical tendencies of their chess careers throughout their lifetimes, an analysis of the efficiency of their play at the various stages of playing against opponents of different proficiency, an analysis of their actions in the various game situations, and their attitude towards themselves and their partners. Generally speaking, a study of the opponent and self-study should follow the same lines.

In *juridical psychology,* the questions involved in the study of thinking are raised when analysing the accuracy and veracity of the witnesses' evidence, working out the strategy of the investigation, building versions, improving the methods of questioning, and in law-making.

The psychology of thinking plays an important role in *computer psychology.* This is a branch of the psychological science studying generation, functioning and structure of the psychic reflection of reality in the activity of individuals and groups engaged in the making and use of computers, including those in the artificial intelligence class. Among the new problems is the study of man's thought activity mediated by the computer, of thinking during interpersonal communication involving the computer, man—computer dialogue (the processes of understanding, explaining), of the laws of mental development of man in the computer age. Applied research into thinking is used in developing the psychological aspect of computer employment.

A comparative analysis of problem-solving by man and by the computer provides a scientific basis for determining the extent to which "computer intelligence" approaches that of man. It has been proved that the major characteristics of man's thought activity (which have been analysed in the present book) are not

reproduced in the existing artificial intelligence systems. It has also been demonstrated that development of artificial systems need not imitate the structure of human intelligence.

The principal applied psychological problems in this field can be summed up as follows: how to make sure that the person using the computer is able to further improve his thinking, what are the psychological conditions making this possible? How to expand the potential of artificial intelligence systems by using the psychological knowledge about thinking processes? The development of practical and applied theoretical issues associated with the problems of artificial intelligence has already made an impact on psychology of thinking and psychology at large. There is reason to believe that this impact is going to grow; it is becoming mutual even now. The development of the artificial intelligence systems has evoked the growing interest of the information science experts in human problem-solving. This interest gives practical value to the entire psychology and promotes its development.

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The Psychology of Thinking

The book contains a systematic exposition of one of the less developed fields of general psychology. One of its purposes is to show how the study of thinking adds to the scientific concepts of the essence of mental reflection, activity, communication, the individual's self-awareness, and the unconscious. It sums up Soviet research in the field and gives a critical analysis of the evolution of world psychology studies.

The book is intended as a teaching aid for training professional psychologists but will undoubtedly be useful for philosophers, teachers, philologists, linguists, researchers into "artificial intelligence", economists, sociologists and psychiatrists.

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